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THIS NUMBER.

It is, we believe, with pardonable pride that we call attention to this issue of the ELECTRICAL REVIEW. It contains an unusual number of valuable contributions, some on scientific subjects, and others dealing with actual construction. The latter are of particular interest, because of the importance and character of the works themselves and the attention which is being directed toward them at this time. The field covered by these articles is broad, for it includes electrical research, invention, application and design. This number also contains an unusual amount of news of electrical affairs, both domestic and foreign, and it inaugurates certain enlargements in the ELECTRICAL REVIEW which have been found necessary, that our readers may be kept fully informed of all developments in the rapidly growing electrical science and industries.

ENGINEERING RESEARCHES IN SCIENCE.

In his presidential address before the engineering section of the British Association for the Advancement of Science, the Hon. Charles A. Parsons suggested that engineers come to the aid of science in executing certain work, or that science adopt engineering methods for pushing its investigations further than it has yet been able. By this it was not intimated that science and engineering do not work together, each, so far as possible, aiding the other, but it was suggested that there are certain investigations which can only be made at great expense, and by means of the highest engineering ability, the results of which would possibly have only a scientific interest. To illustrate this it was suggested that deeper borings might be made into the earth. The greatest depth that has yet been reached is only about one mile, and what lies beyond this can only be surmised. When led on by coal beds or rich ore, the money necessary for penetrating so deeply into the earth is easily secured, but, as the depth increases, the cost and difficulty of mining also increase, and a point may be reached where further work at increased depths becomes unprofitable. To go deeper for the sake of finding out what lies below is a proposition which does not appeal to the men who are supplying the money. In all such work, the engineer would be helpless unless aided liberally with money. On the other hand, once the necessary money is secured, there would be no difficulty in finding the engineering ability to conduct the work.

A Chance for the Wealthy.

We believe that if this one problem should be properly presented to those of our wealthy men who have already shown their

willingness to supply money for scientific purposes, they would gladly accept the opportunity. Enormous sums and lives have been lost in attempts to reach the North Pole. Here is a problem which, while difficult and expensive, would not be dangerous, and which would probably result in information far more valuable than can be obtained by any polar expedition, and which would possibly lead to discoveries of great importance, practical as well as scientific. This, of course, is only one of many fields of investigation which are to-day neglected for want of money. It is, however, one which would probably arouse a good deal of popular interest. All such researches, indeed, for that matter, all scientific researches require ability, time and money. Science is seldom at a loss for the ability and willingly gives the time, the limiting factor being, in nearly all cases, a lack of money.

COMMERCIAL LIMITS OF TRANSMISSION.

Length and consequent cost of conductors are not the only factors that fix commercial limits to electrical transmission. On the contrary, in the greater number of actual cases, the length of line is decided without much regard to the cost of conductors.

The reason for this is that various conditions usually limit the length of transmission long before the cost of conductors becomes prohibitive. As is well known, the ability to carry line voltages up to anything less than 60,000 without encountering unknown problems of insulation makes it practicable to hold the cost of line conductors at a constant moderate figure per maximum horse-power delivered, without regard to distance up to, say, 100 miles. But though the cost of conductors may be held constant for rather wide variations of length, the investment in poles, cross-arms, insulators and the right of way necessarily goes up directly with the distance covered by a transmission.

Even the line as a whole, poles, wires and all, seldom fixes by its cost the limits of a transmission. A much more frequent limit is the consumption of all the energy available from a water power, at points that are reached by a comparatively short transmission. In many such cases the problem is how to get enough power to supply cities that are already reached by a transmission system, rather than to determine how much farther it may be extended without excessive cost. The transmission from Apple River falls stops at St. Paul, twenty-five miles away, even though Minneapolis is only ten miles beyond, because the former city requires more electrical energy than the water power can furnish. Albany and Schenectady, the former forty and the latter thirty miles from Spier falls, are the limits of transmission from the generating station there, because its capacity is no more than enough to carry their loads and that of the intervening territory. Even the great power development at Niagara falls has its capacity nearly taken up by the local loads and those at Buffalo, only twenty-three miles away. In some cases the cost of right of way, pole line, pins and insulators is such as to prevent a transmission, without regard to the cost of conductors, because the amount of power that can be sold at the point where the transmission would terminate is small. For this reason very long transmissions are seldom made to small isolated cities or towns. Similar considerations prevent the development of small water powers for transmission to very distant points, because however small the cost of conductors may be the amount of energy to be sold will not pay a fair return on the investment in right of way and pole line.

At this point comes a great advantage in the combination of small water powers, or of small markets, or of both. In a number of instances comparatively small water powers that singly could never be transmitted to any great distance at a profit have been combined to form a rather large and long transmission system. Such cases depend for their success on the fact that numerous electric generators located in water-power plants that are tens and even scores of miles apart can be readily operated in multiple on the same connected loads. No better examples can be found of this practice than those in California, a land of numerous small water powers. One such case may be seen in the system of the California Gas and Electric Company that stretches from the Sierra Nevada mountains to the shores of San Francisco and San Pablo Bay, an extreme distance of 232 miles. The general trend of the main transmission lines of this system is southwest from the mountain slopes to tide water, and no less than five power-houses ranged north and south on the western slope of the mountains, and more than ninety miles in extreme distance apart, are connected to these lines. Another striking example of the same sort is found near the mountains of Southern California, where three power-houses along Mill Creek and two more on the Santa Ana river are connected in multiple for the eighty-three-mile transmission to Los Angeles. In the combination of scattered markets to form a sufficient objective for a long transmission of water power, the system of the California Gas and Electric Company again furnishes an excellent example. The lines of this system do not enter San Francisco but terminate in the cities and towns along the opposite side of the bay. Oakland, the largest of these cities, is too small to warrant a transmission of more than 200 miles, the approximate distance between it and De Sobla power-house, or even the transmission of 142 miles from the Colgate power-house.

Besides these places the main transmission line supplies a number of towns on its way. Another important combination of markets for electric power, this time in the east, is that of Schenectady, Troy and Albany, which mark the southern limits of the transmission from Spier falls. It may perhaps be questioned whether the forty-mile transmission to Albany alone would have been warranted by the electric load there, but with Schenectady on the one side, Troy on the other and a number of smaller places on the way the question vanished.

Cost of coal is even more important than the cost of copper in fixing the limits of electric transmission from water power. The fact that water power can be developed at a lower cost than steam power is the main inducement to its transmission. In the production of steam power, labor and fuel are the two greatest items of expense, and so the price of fuel has an important bearing on the distance to which water power can be transmitted at a

profit. The influence of the cost of fuel on the length of profitable transmission is more notable in the case of small than in that of large powers, because where very large units are concerned energy developed by water usually costs less, even when transmitted, than energy developed by steam from cheap fuel. In such a case the fixed charges on right of way and pole line are reduced to a very small amount per unit of power transmitted. Where energy is to be consumed at a given point at the rate of only a few hundred horse-power or less, the practicable length of transmission for water power will change very rapidly with the price of fuel. Under these circumstances the price of fuel must be very high to warrant a transmission that is really long. Illustrating the tendency of rather high prices for coal to increase the range of transmission for moderate powers the line twenty-five miles long that carries a maximum of 3,000 kilowatts into St. Paul may be cited. On the other hand, the low price of fuel in Buffalo is not sufficient to keep out nearly 20,000 kilowatts from Niagara falls, twenty-three miles away. In spite of the price of three dollars per ton for soft coal in Montreal, the power from Shawinigan falls to the extent of many thousand kilowatts is displacing steam engines in that city.

THE TELEPHONE RELAY.

On another page of this issue appears an article by Dr. John Trowbridge on that interesting and important subject, the invention of a practical telephone relay. The perfection of a practical telephone relay, it need hardly be said, would be an event of the greatest importance in telephone engineering. The problem is an old one—comparatively speaking only—telephone engineering is itself but a young profession. The difficulties are great, the worst of these being due to the inevitable imperfections of any mechanical device.

Great Sensitiveness Necessary.

The telephone receiver is itself an exceedingly sensitive device when compared with other mechanical instruments, but it is nevertheless far from perfect. The same is true of the transmitter, and, as is pointed out by Dr. Trowbridge, much of the success attained by telephony is due to the fact that the mind of the listener is able to supply the omissions caused by these two devices. Adding a relay to the line introduces a third point where distortion may take place. The relay not only receives the distorted vibrations set up by the transmitter, but it adds to these those caused by its own imperfections. The defect is thus accumulative, and a point is soon reached where the ear is not able to translate the sounds which it hears. A successful relay must, therefore, be, if anything, more perfect and more sensitive than the receiver and transmitter. Could the latter be so improved as to allow a less sensitive relay to be used, there would then be no need for it.

Encouraging Results.

Dr. Trowbridge's work, while assuring us of no immediate results, is encouraging. That he was able to introduce his relay into a line, and thereby improve the transmission, is very significant.

WHY LOOK FOR MORE TROUBLE?

The administration of the city of Baltimore is contemplating—or, at least, says that it is—the erection of a municipal light, heat and power plant. We had been led to believe, from all reports, that Baltimore was confronted with enough big problems to require the constant attention of all the city officers, so that it is rather surprising to learn that it is looking for more trouble. Would it not be better to concentrate all energy and ability in straightening out the present difficulties, and leave the question of a municipal plant to the future? There will be no lack of demand on the dock loan, from which the funds required for the plant may be drawn, and the fewer small matters the city officers have to deal with, the better will they conduct the larger ones. It would be the part of wisdom to straighten out the tangle which has arisen over street improvements and building permits. Why trouble about a little smoke, when there are so many other things far more pressing to be done? We rather suspect that this proposal is nothing more than a club to hold over the lighting companies, but doubt if it accomplishes any good.

THE NEW YORK SUBWAY.

A noteworthy incident in the history of the New York subway, which occurred during the week just closed, was the trip of inspection made by the American Institute of Electrical Engineers and the foreign engineers and delegates to the International Electrical Congress, to be held next week at St. Louis. This was the first time that any large body of persons not connected with the work had been carried through the subway on one of the regular trains. This great engineering work, which has been so many years planning and building, will shortly be put into actual service, so that it is interesting to recall, at this time, some of the facts connected with its early history.

Early Attempts.

As early as 1850, the need for better means of getting about Manhattan Island was felt. The population of this narrow strip has always been a rapidly growing one, and at that time was over 500,000. The old horse-car systems were the first means adopted for supplying the needs, but, before many years, its capabilities had been exhausted, and better methods were sought. The elevated systems, authorized in 1875, for a time greatly improved conditions, but finally the work became too heavy for them, and additional facilities were demanded. In the meantime, the electric surface systems had been developed, and had replaced, almost entirely, the old horse-car lines. These increased the capacity of the lines and the speed, but they were overloaded from the first. A cable system was tried, but was soon transformed to an electric. Demands were now made, not only for increasing the capacity of the elevated system, but for providing relief in other directions, and in 1890 and 1891, under legislative action, rapid transit commissions were appointed to consider the problem and to bring forward plans which would meet the increasing needs. Little or nothing was accomplished until the present commission was appointed in 1894. This commission, in 1897, drew up general plans for a subway, which was

authorized by popular vote. The contracts for the work were let in 1900, the ground being broken first on March 24 of that year. This work has been pushed rapidly, until to-day the tunnel is finished, generally speaking, from the City Hall throughout the main line on the west side as far as One Hundred and Forty-fifth street and Broadway, and the east side branch up to Lenox avenue and One Hundred and Forty-second street. Tracks and the third rail are in place through these portions, and the stations are, for the most part, completed.

Elevated Roads Electrified.

While this was going on, the elevated systems have been converted from steam to electricity; but while this increased enormously their carrying capacity, they are now unable to handle satisfactorily the crowds during the rush hours, and the congestion is steadily growing worse. The opening of the subway will give immediate relief.

The Subway.

The subway itself is really a covered railroad laid below the street level; it is not a tunnel. The structure is rectangular in form, and through it four tracks are laid from the lower end up to the point where its branches at One Hundred and Fourth street. The outer tracks are for local trains, to make frequent stops at stations about one-quarter of a mile apart, and to make a schedule speed of about eighteen miles an hour. The inner tracks are for the express trains, which will be run at all hours of the day. These will stop at stations about a mile and a half apart, and make a schedule speed of thirty miles an hour. The main line of the subway, from the City Hall to the point of division, is a little over seven miles in length, each of the branches being about the same length. Much of the work called for the highest engineering ability, for not only was the greater part of the cutting through rock, but it was required that the work should be done in such a way as not to block the traffic on the streets. That it has been carried through so promptly, and with so few accidents, reflects great credit upon the rapid transit commission, upon the technical staff and upon the builders.

SELENIUM AS A FACTOR IN THE DEVELOPMENT OF ELECTRIC LAMPS.

Attention has frequently been called to the handicap under which the electric light engineer works, due to the inefficiency of his lamps. The subject is of such importance that no apology is needed for referring to it again. In studying the figures of luminous efficiency of an electrical system, one is greatly impressed with the poor showing made, but one does not always perceive the disadvantage of having the most inefficient device at the last stage of the process of producing light.

Where the Losses Occur.

In the ordinary process of producing light by means of coal, a steam plant and electric generator, there are two stages at which the process of transformation is poor. The transfer of heat in the coal to the steam in the boiler is fairly satisfactory, but when we attempt to convert the heat of the steam into mechanical power, great losses occur, due not to the inefficiency of the engine as a machine, but to the conditions under which we find it possible to work, these making the method itself very inefficient. From here on until we reach the lamp, the efficiency of transformation and transmission is merely a question of good design; but, at the lamp, we again employ an inefficient method; the efficiency of the incandescent lamp is usually put at about six per cent.

The efficiency of the average steam plant up to the dynamo may be said to be about ten per cent. This is unfortunately low, but the chief disadvantage of the process utilized by the steam engine is the waste of coal. However, since the process is inefficient, a larger boiler and a larger engine are necessary than would be the case if a higher efficiency could be obtained. But these losses take place at an early stage in the transformation. On the other hand, the losses in the lamp are not only the greatest in proportion, but take place at the last stage, thereby requiring more copper to be used in the line, a larger dynamo, a larger engine, and a larger boiler. In fact, the inefficiency of the electric lamp handicaps the entire system. If the efficiency could be raised from six to sixty per cent, one-tenth of the copper deemed necessary to-day would be sufficient to give the same results, and all the apparatus could be reduced in a like proportion. Perhaps this way of looking at present conditions may appeal more strongly to the engineer than a mere protest against the great waste of fuel.

Improve the Lamp.

Thus, it would seem that the proper point at which to attempt to improve lighting systems would be the lamp itself, since an improvement here would be beneficial to the entire system. Any means, therefore, of increasing our knowledge of electric lamps must be of much value. Photometric studies are exceedingly important, and an easy and accurate means of making them free from the personal error of the observer would remove the principal source of difficulty in this work. As yet, no entirely satisfactory substitute for the eye has been found. A suitable device must measure the luminous rays, and not respond principally to the heat rays or to the chemical rays.

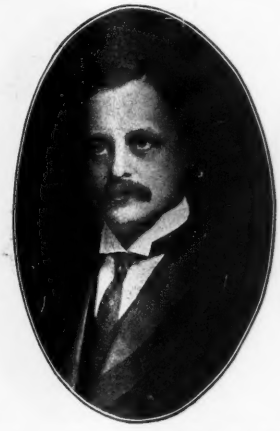
Selenium Photometry.

A substance which fills this requirement, to some extent, at least, is selenium, and its use as a means for measuring light is described on another page of this issue, by Professor Fitzhugh Townsend. Selenium, fortunately, responds principally to the luminous rays, these producing great changes in its resistance. However, in making use of selenium for this purpose, some, and what may, perhaps, prove to be serious, difficulties are to be overcome. It does not respond equally to all rays; it becomes fatigued, its indication at any instant depending upon its recent history. Trouble may be anticipated in reproducing accurately in one instrument the performance of another. These troubles should not be insurmountable, but they can only be overcome after much careful work has been done. This work is tedious and slow, but the subject is of such importance that it is to be hoped this investigation will not stop where it is, but will be pushed further. Any research promising at all to better our present conditions justifies the expenditure of the time required to determine whether the first hope is likely to be realized or not.

The International Electrical Congress.

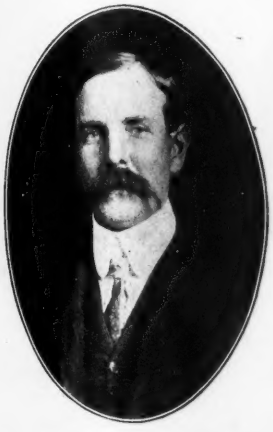
The Arrival and Entertainment of the Delegates, the Circular Tour to St. Louis, Programme and Sections.

THE most of the visiting delegates to the International Electrical Congress from Great Britain and the Continent arrived last week. A number of delegates from the Associazione Elettro-



DR. ELIHU THOMSON, PPESIDENT INTERNATIONAL ELECTRICAL CONGRESS.

tecnica Italiana arrived on August 25, and were entertained by the local committee of the American Institute of Electrical Engineers until their departure on Tuesday morning, September 6, for Schenectady, N. Y., on the circular tour arranged by the American Institute of Electrical Engineers. During this time the Italian contingent, along with



DR. A. E. KENNELLY, GENERAL SECRETARY INTERNATIONAL ELECTRICAL CONGRESS.

several visitors from England and other parts of Europe, journeyed to Boston, where a large number of delegates and visitors from the British Institution of Electrical Engineers were met on Saturday, September 3. On the morning of Sunday, September 4, the consolidated party arrived in New York, where provision had been made by the local committee for their entertainment.

At 2 o'clock on Sunday, September 4, about 500 members of the Institute and visitors were tendered a steamer ride by Mr. James G. White, a member of the committee, up the Hudson river about as far as West Point. Here the steamer turned without landing, and took a course down the river and through the lower bay, following the international yacht-race course, and anchorage was made at Dreamland Park, Coney Island, about 7.30 in the evening, returning about midnight.

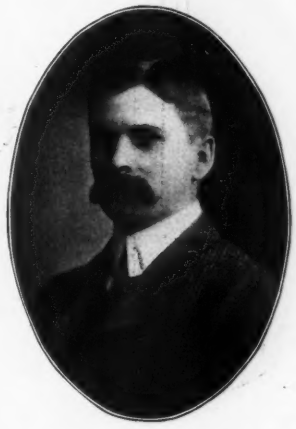
On Monday, September 5, the members of the Institute and the visitors assembled at the City Hall station of the Interborough Rapid Transit Company. There was made up at this point a train of eight cars, in charge of Mr. Lewis B. Stillwell, the electrical director of the Interborough company. Leaving the train at Fifty-ninth street, the party walked across the city to the new power station of the Interborough Rapid Transit Company at Fifty-eighth street and the North river.

Leaving the Fifty-eighth street power station, the party was conveyed by the steamer Nassau, of the Long Island Railroad, and the steamer Western Union, of the Western Union Telegraph Company, up the Hudson river and through the Harlem ship canal to the Kingsbridge power station of the Interborough Rapid Transit Company. During this part of the trip the party was met by the fireboat Abram S. Hewitt, and a wonderful display of the capabilities of this fire-fighting steamer was witnessed.

After leaving the Kingsbridge power station a buffet luncheon was served, and the party proceeded to the Seventy-fourth street or Manhattan Railway station of the Interborough Rapid Transit Company.

From this point the party was conveyed to the Thirty-eighth street station of the New York Edison company.

On the evening of September 5 the American Institute of Electrical Engineers, cooperating with the New York reception committee, tendered a banquet and reception to the British Institution of Electrical Engineers, the Associazione Elettrotecnica Italiana, and other visitors, at the Waldorf-Astoria. President Fornes, of the board of aldermen, welcomed the visitors. The other speakers were Bion J. Arnold, president of the American Institute of Electrical Engineers; Robert Kaye Gray, president of the British Institution of Electrical Engineers; Professor Moisè Ascoli, president of the Italian association; Wilhelm von Siemens, Professor



MR. BION J. ARNOLD, CHAIRMAN EXECUTIVE COMMITTEE, INTERNATIONAL ELECTRICAL CONGRESS, PRESIDENT AMERICAN INSTITUTE ELECTRICAL ENGINEERS.

Elihu Thomson, Professor John Perry, C. A. Coffin, and John W. Lieb, Jr., president-elect of the American Institute of Electrical Engineers.

The train carrying the members of the American Institute of Electrical Engineers and their guests on the circular tour for St. Louis left the Grand Central sta-

MR. JOHN W. LIEB, JR., PRESIDENT-ELECT AND CHAIRMAN OF GENERAL RECEPTION COMMITTEE, AMERICAN INSTITUTE ELECTRICAL ENGINEERS, CHAIRMAN SECTION E, INTERNATIONAL ELECTRICAL CONGRESS.

tion 9 A. M., Tuesday, September 6. The train consisted of two baggage cars, one buffet car, two dining cars, two combination drawing and stateroom cars, two regular Pullman sleepers, and one combination stateroom and combination car A parlor car was also attached to the train,

in which were the guests of the General Electric Company, among whom were Messrs. T. C. Martin, Professor F. S. Crocker, Dr. S. S. Wheeler, Mr. Frank Sprague, Mr. Siemens and Mr. C. W. Price. Mr. C. A. Coffin, president; Gen. Eugene Griffin, vice-president and general manager, and Mr. W. B. Potter, chief engineer of the railway department of the

PROFESSOR E. L. NICHOLS, CHAIRMAN, SECTION A.

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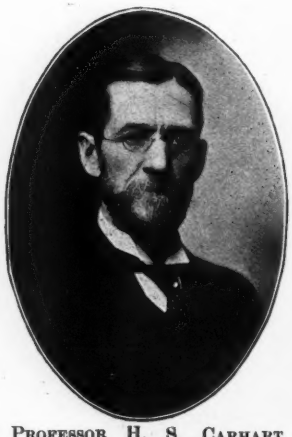
PROFESSOR SAMUEL SHELDON, SECRETARY, SECTION B.

General Electric Company, met the party in New York and accompanied them to Schenectady. The following visitors will undertake the circular tour arranged for the foreign delegates and other visiting electrical engineers by the American Institute of Electrical Engineers. In addition to these, however, there were quite



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MR. CHARLES F. SCOTT, CHAIRMAN, SECTION D.

DR. LOUIS BELL, SECRETARY, SECTION D.

MR. GANO S. DUNN, SECRETARY, SECTION E.

a number of passengers who intended to leave the part at various stopping places:

Edoardo Ambrosano; Bion J. Arnold; Prof. Moisè Ascoli; Signora Liliah Ascoli; A. F. T. Atchison; G. Balfour; R. S. Ball; F. E. Barker; W. A. Barnes; Ing. Giovanni Barosi; Ing. Carlo Barzano; D. Bates; Mrs. Bates; G. Conrad Blair; Ing. C. Vincenzo Brazzola; George Bullock; Ing. Alfonso Carelli; Ing. Federico Carini; Ing. Nicostrato Castellini; Ing. Filippo Cavalieri; W. J. Clark; John T. Connolly; Mrs. Connolly; Prof. J. D. Cormack; Mrs. Cormack; Col. R. E. Crompton; Camillo Albino Curti; Ing. Filippo Danioni; E. G. Dennison; J. R. Dick; Alex Dow; W. Duddell; James Edgar; Ing. Edoardo Egger; Charles Ekstrand; R. S. Erskine; Mrs. Erskine; Prof. Gino Fano; Theo. Foilden; J. A. Foster; Ing. Luigi Galimberti; Dott. Ettore Gamba; W. Geipel; Ing. Gian Teodoro Giorgetti; Ing. Francesco Giudice; Dr. R. T. Glazebrook; Antonio Gonzalez; P. G. Gossler; C. B. Graham; R. Kaye Gray; F. E. Gripper; G. G. Grower; Hon. R. Hammond; Miss Hammond; H. E. Harrison; Charles C. Hawkins; M. Hayashi; John Coffee Hays; Thos. Hesketh; Mrs. Hesketh; F. Hope-Jones; Wilson S. Howell; C. W. Hutton; M. Jennison; Ing. Emanuele Jona; W. H. Kernot; F. C. Kidman; F. Kloeckner; Hubert Leisse; H. Ward Leonard; Mrs. Leonard; John W. Lieb, Jr.; Mrs. Lieb; Emil H. Liebert; G. C. Lloyd; Prof. Luigi Lombardi; F. M. Long; Benjamin Longbottom; Prof. Ferdinando Lori; Ing. Amatore Maffezzini; R. S. McLeod; Silvio Magrini; J. Marshall; R. B. Matthews; John L. Marr; W. B. Marr; F. O. Mills; W. E. Moore; D. K. Morris; John T. Morris; L. G. E. Morse; E. H. Mullin; Mrs. Mullin; F. H. Nalder; George Newbury; Ing. Arnaldo Odazio; Miguel Otamendi; Augusto Pancaldi; Robert B. Perring; Prof. John Perry; Miss A. M. Perry; Ing. Antonio Pesenti; Ing. Alberto Picchi; Dott. Alberto Pirelli; Luigi Pizzi; Ralph W. Pope; W. G. T. Pope; Mrs. Pope; Ing. Eugenio Prandoni; A. Prucker; A. P. Pyne; Calvin W. Rice; Mrs. Rice; Emilio Rieti; G. H. C. Risch; Ing. Guido Robbo; Ing. Alberto Rubini; Carl A. Schaefer; E. B. Schattner; Chas. F. Scott; E. K. Scott; W. H. Scott; E. H. Seaman; A. B. See; Mrs. See; Master See; Ing. Ulderigo Segre; Ing. Angelo Silva; C. H. Sharp; P. S. Sheardown; Gustave Snoeck; Ing. Tullo Soragni; Frank J. Sprague; Mrs. Sprague; Miss A. Stower; Giuseppe Stramezzi; Ing. G. Stucky; W. Summerscales; C. D. Taite; Max J. E. Tilney; Philip Torchio; Mrs. Torchio; Ing. Gianfranco Tosi; Calvert Townley; R. Tree; Achille Venzaghi; A. G. P. Webb; H. G. Whiting; George Wilkinson; R. Ffolliott Willis; Mrs. Willis; E. B. Woollan; Alexandre Zelewsky.

On arrival of the train at Schenectady the visitors were conducted to the large building which is now nearing completion for the construction on a large scale of the Curtis steam turbine. In the spacious gallery of this building a sumptuous

luncheon was served. The guests were received by the prominent officials of the General Electric Company, and were seated at a number of large circular tables which were prettily decorated with smilax and groups of palms.

At 3 o'clock the male members of the party started out to visit the various shops of the company in groups of eight or ten, accompanied by guides, who conducted the guests through the works, pointing out and describing the features of greatest interest. The building that attracted the most attention was the new power station, which, when completed, will have a capacity of 12,000 kilowatts made up of eight 1,500-kilowatt generator units, each driven by a Curtis steam turbine. This station will supply current for many purposes in the works, and will also serve as a reserve source of current for the Schenectady lighting plant and railway system in cases of emergency.

At half-past five o'clock the various groups of the party reconvened near the gates of the works in time to observe the departure of the ten thousand employés of the works at the close of their day's work.

While the gentlemen of the party were engaged in inspecting the General Electric works, the visiting ladies were taken in charge by a special committee, and were shown the General Electric Company's restaurant, in which the cooking is done by electricity, after which they were taken on a trolley and automobile ride to the Mohawk golf links.

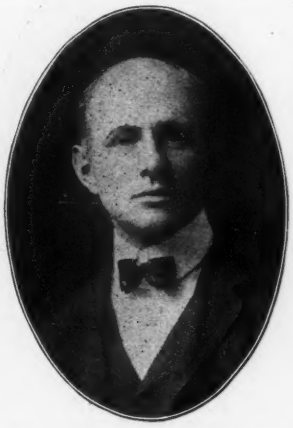
At 6 o'clock the entire party boarded four of the cars of the Schenectady & Ballston electric road for Ballston, which town was reached at 7.30 P. M. One of these cars was equipped with the General Electric compensated motors for operation by direct and single phase currents.

At Ballston the party again embarked on the circular tour train, and at 8 o'clock reached Saratoga. Dinner was partaken of at the United States Hotel, and after a most enjoyable day of traveling and sightseeing, which was enhanced by beautifully clear and cool weather, the party left Saratoga at 10 P. M. for Montreal.

On arriving at Montreal the delegates were met by the following members of local reception committee: Professor R. B. Owens, chairman; Henry D. Bayne, secretary; Aldred Baylis and Messrs. Barbour, Bourson, Redpath, Collyer and Herdt. The delegates were conveyed to the Windsor Hotel in carriages, and after breakfast a start was made by Grand Trunk Railway for Lachine, where the entire party boarded the steamboat "Algerine," which was prettily decorated, as guests of the mayor and corporation of Montreal, to shoot Lachine Rapids.

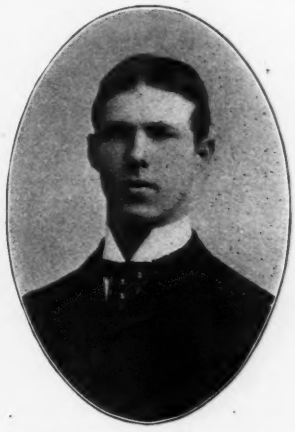
At Lachine Professor Owens introduced Alderman Sadler, who, on behalf of Mayor Laporte, welcomed the delegates to the city of Montreal. This trip was greatly enjoyed. On landing from the steamboat the party proceeded to the main receiving substation of the Montreal Light, Heat and Power Company, where, after luncheon, a trip was made through the city on special cars. At 4.30 o'clock a reception was tendered to the delegates by the chancellor and governors of McGill University. In the evening a party was given by local reception committee at

DR. LOUIS DUNCAN, CHAIRMAN, SECTION F.

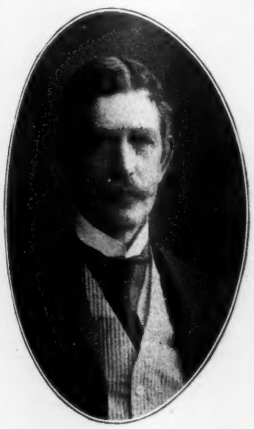


MR. A. H. ARMSTRONG, SECRETARY, SECTION F.

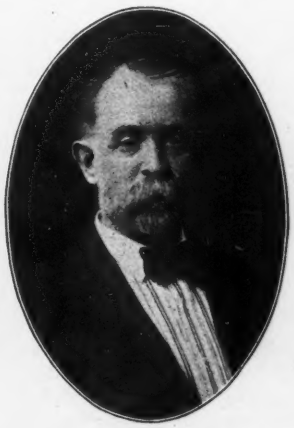
MR. F. W. JONES, CHAIRMAN, SECTION G.



MR. B. GHERARDI, SECRETARY, SECTION G.

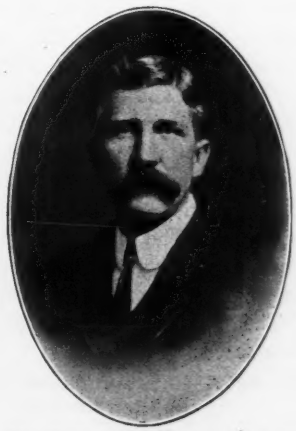


DR. W. J. MORTON, CHAIRMAN, SECTION H.



MR. W. J. JENKS, SECRETARY, SECTION H.

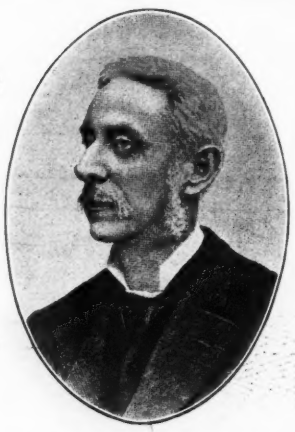
MR. ERNEST H. DAVIS, PRESIDENT NATIONAL ELECTRIC LIGHT ASSOCIATION.



MR. ERNEST MCCLEARY, PRESIDENT NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION.

Forest and Stream Club, returning at 11 o'clock to Montreal. On Thursday most of the party spent the day on a trip to Shawinigan falls.

The schedule called for the party leaving Montreal on Thursday evening, at 8 o'clock, arriving at Niagara Falls at 9 A. M., September 9. Leaving Niagara at 6 P. M. the same day, arriving at Chicago 7.30 A. M. September 10. The train will leave Chicago at 11.45 P. M., arriving at St. Louis at noon September 11.



COL. R. E. CROMPTON, DELEGATE, BRITISH INSTITUTION OF ELECTRICAL ENGINEERS.

PROFESSOR JOHN PERRY, DELEGATE, BRITISH INSTITUTION OF ELECTRICAL ENGINEERS.

MR. H. E. HARRISON, DELEGATE, BRITISH INSTITUTION OF ELECTRICAL ENGINEERS.

MR. W. DUDDELL, HONORARY SECRETARY, DELEGATION FROM BRITISH INSTITUTION OF ELECTRICAL ENGINEERS.

The International Electrical Congress will begin its sessions in the Music Hall of the Coliseum, St. Louis, at 9.30 A. M., on Monday, September 12. The Coliseum is located at Olive and Thirteenth streets, in the city district of St. Louis. The bureau of information and the offices of the secretary and treasurer will be in the Coliseum building, and any of the visitors who have not already affiliated themselves with the congress may do so upon arrival in St. Louis. Sessions of the sections will be held on the second floor of the Coliseum on Tuesday, Wednesday, Thursday and Friday, from 9 A. M. to 1 P. M.

The following programme has been announced:

SECTION A.—GENERAL THEORY—MATHEMATICAL, EXPERIMENTAL.

Chairman, Professor E. L. Nichols; secretary, Professor H. T. Barnes.

"On the Relation Between the Sun's Rays and Electromagnetic Disturbances on the Earth," Professor Dr. S. Arrhenius.
"Systems of Electric Units" (A. E. Ital. paper), Professor Dr. Moise Ascoli.
"Metallic Conduction from the Standpoint of the Electronic Theory," Professor Dr. Paul Drude.
"Electrical Standards," Professor Dr. W. Jaeger.
"Magnetostriction," Professor H. Nagaoka.
"The Theory of Ionization by Collision," Professor J. S. Townsend.
"The Corpuscular Theory," Professor J. J. Thomson.
"Secondary Standards of Light," M. J. Violle.
"Condensation Nuclei," Professor C. T. R. Wilson, F. R. S.
"Recent Progress in Magneto-Optics," Professor P. Zeeman.
"Atmospheric Nuclei" (A. Phys. S. paper), Dr. Carl Barus.
"The Mechanical Equivalent of Heat Measured by Electrical Means" (Roy. Soc. Canada, paper), Professor Howard T. Barnes.
"The State of Our Knowledge Regarding the Earth's Magnetism and Recent Remarkable Magnetic Storms," Dr. L. A. Bauer.
"Magneto-Optics" (A. Phys. S. paper), Professor D. B. Brace.
"The Absolute Value of the Electromotive Force of the Clark and Weston Cells," Professor H. S. Carhart and Professor G. W. Patterson, Jr.
"The Electric Arc," Professor C. D. Child.
"Coherer Action," Dr. K. E. Guthe.
"The Alternating-Current Theory of Transmission Speed over Submarine Telegraph Cables," Dr. A. E. Kennelly.
"The Electrical Conductivity of Gases," Professor E. Percival Lewis.
"Radioactivity of Mineral Oils and Natural Gases," Professor J. C. McLennan.
"Electrostriction," Professor Louis T. More.
"The Unobtained Wave-Lengths Between the Longest Thermal and the Shortest Electric Waves Yet Measured," Professor E. F. Nichols.
"Standards of Light," Professor E. L. Nichols.
"The Magnetic Effect of Moving Charges," Dr. H. Pender.

PROFESSOR FERDINAND WEBER, DELEGATE, GOVERNMENT OF SWITZERLAND.

"Electrical Impulses and Multiple Oscillators" (A. I. E. E. paper), Professor M. I. Pupin.
"The Absolute Measurement of Inductance," Dr. E. B. Rosa and Mr. F. W. Grover.
"Radioactive Change," Professor E. Rutherford.
"Spectra of Gases at High Temperatures," Professor J. Trowbridge.
"Report on Recent Developments in Electrical Theory" (A. P. S. paper), Professor A. G. Webster.
"The So-called International Electric Units," Dr. Frank A. Wolff.
"The Discharge from Points," Professor J. Zeleny.

SECTION B.—GENERAL APPLICATIONS.

Chairman, Professor C. P. Steinmetz; secretary, Professor Samuel Sheldon.

"The Commutation of Direct and Alternating-Current Machines," Professor E. Arnold and J. L. LaCour.
"Calculation and Tests of Alternators," M. André Blondel.
"Kinetic Variations of Electromotive Force in Dynamo Electric Generators and its Influence on their Operation in Parallel," M. Paul Boucherot.
"Theory and Method of Operation of Repulsion Motors," Dr. O. S. Bragstad.
"Standardization of Dynamo Electric Machinery and Apparatus," Colonel R. E. Crompton.
"Concerning Natural Radioactivity of the Atmosphere and the Earth," Professors Drs. Elster and Geitel.
"The Distribution of Voltage and Current in Closed Conducting Networks," Herr Clarence Feldmann and Joseph Herzog.
"Recent Developments in Compounded Alternators with Alternating-Current Self-Excitation," M. Alexander Heyland.
To be announced, W. M. Mordey.
"Rectifiers," M. A. Nodon.
"Electricity in Ancient Egypt," Sir W. H. Preece.
"The Leakage Reactance of Induction Motors," Professor C. A. Adams.
"Electric Motors in Shop Service," Mr. C. Day.
"Sparking Distances Corresponding to Different Voltages," Mr. H. W. Fisher.
"The Influence of Wave Shape upon Alternating-Current Meter Indications," Professor E. B. Rosa, Dr. M. G. Lloyd and Mr. C. E. Reid.
"The Regulation of Alternators," Mr. D. B. Rushmore.
"The Design of Insulators," Professor H. J. Ryan.
"The Equipment of a Commercial Testing Laboratory," Dr. Clayton H. Sharp.
"Very High Voltage Transformers," Professor H. B. Smith.

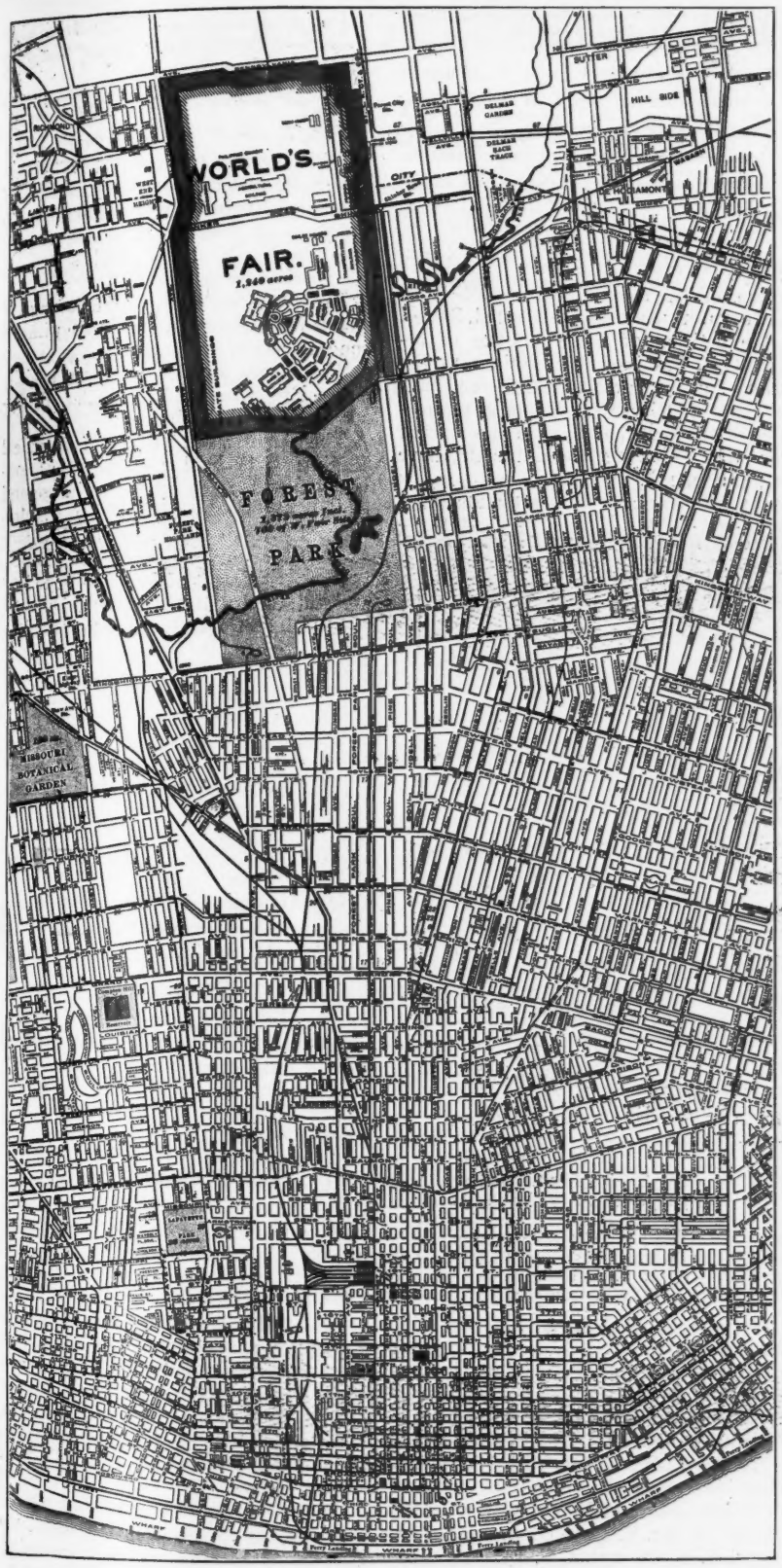
SECTION C.—ELECTROCHEMISTRY.

Chairman, Professor H. S. Carhart; secretary, Mr. Carl Hering.

"Electrometallurgy of Nickel," Geh. Reg. Professor Dr. W. Borchers.
"Electrolytic Methods for the Rapid Production of Copper Sheets and Tubes," Sherard Cowper-Coles.
Subject to be announced, Dr. F. Dolezalek.
"Electrical Extraction of Nitrogen from the Air," J. Sigfrid Edstrom.
"Alumino-Thermics," Dr. H. Goldschmidt.
"Electrolytic Disturbances in the Earth," Professor Dr. F. Haber.
"Electrometallurgy of Iron and Steel," Dr. P. L. T. Héroult.
"Electrolysis of Fused Salts," Professor Dr. Richard Lorenz.
"Electrolysis and Catalysis," Professor Dr. W. Ostwald.
"Electrolytic Smelting of Sulphide Ores," Mr. J. Swinburne.
"The Chemistry of Electroplating" (A. Electrochem. S. paper), Professor W. D. Bancroft.
"The Lead Voltameter," Mr. A. G. Betts and Dr. Edward F. Kern.
"The Preparation of Materials for Standard Cells and their Construction" (A. Electrochem. S. paper), Professor H. S. Carhart and Dr. C. A. Hulett.
"The Present Status of the Edison Storage Batteries," Dr. A. E. Kennelly and S. E. Whiting.
"The Silver Voltameter," Dr. K. E. Guthe.
"The Electrochemical Series of the Metals" (A. Electrochem. S. paper), Professor L. Kahlenberg.
"The Energy Absorbed in Electrolysis," Professor J. W. Richards.
"The Relation of the Theory of Compressible Atoms to Electrochemistry," Professor T. W. Richards.

SECTION D.—ELECTRIC POWER TRANSMISSION.

Chairman, Mr. Charles F. Scott; secretary, Dr. Louis Bell.



MAP OF CITY AND SUBURBAN SECTION OF ST. LOUIS, SHOWING STREET CAR LINES AND WORLD'S FAIR GROUNDS. ELECTRICAL CONGRESS MEETS AT THE COLISEUM, OLIVE AND THIRTEENTH STREETS.

"Electrical Transmission Plants in Switzerland," Sig. E. Bignami.

"A Method of Designing Induction Motors," H. M. Hobart.

"Transmission of Alternating Currents Over Lines Possessing Capacity," Mons. Maurice Leblanc.

"Utilization of Hydraulic Powers in Italy," Professor G. Mengarini.

"High-Potential Long-Distance Transmission and Control," F. G. Baum.

"Conductors for Long Spans," F. O. Blackwell.

"The Use of Aluminum as an Electrical Conductor," H. W. Buck.

"High-Tension Insulators," V. G. Converse.

"The Construction and Insulation of High-Tension Transmission Lines," M. H. Gerry, Jr.

"The Bay-Counties Transmission System," L. M. Hancock.

"Some Practical Experiences in the Operation of Many Power Plants in Parallel," R. F. Hayward.

"Some Difficulties of High-Tension Transmission and Methods of Mitigating Them," J. F. Kelly and A. C. Bunker.

"Transmission and Distribution Problems Peculiar to the Single-Phase Railway System," P. M. Lincoln.

"The Maximum Distance to Which Power Can Be Economically Transmitted" (A. I. E. E. paper), Ralph D. Mershon.

"Pioneer Work of the Telluride Power Company," P. N. Nunn.

"The High-Tension Transformer in Long-Distance Power Transmission," J. S. Peck.

"American Practice in High-Tension Line Construction and Operation" (N. E. L. A. paper), Dr. F. A. C. Perrine.

"Theory of the Single-Phase Motor" (A. I. E. E. paper), Dr. C. P. Steinmetz.

SECTION E.—ELECTRIC LIGHT AND DISTRIBUTION.

Chairman, J. W. Lieb, Jr.; secretary, Mr. Gano S. Dunn.

"Impregnated Arc Light Carbons and Lamps," Professor André Blondel.

"Single-Phase Motors," Herr Max Déri.

"Rates for Electricity Supply," Herr E. de Fodor.

"Insulating Materials in High-Tension Cables" (A. E. Ital. paper), Sig. Ing. E. Jona.

"Upon a Means for Compensating the Series Connection of Induction Motors," Professor W. Kubler.

"Stroboscopic Observations of the Arc" (A. E. Ital. paper), Professor L. Lombardi.

"The Yorkshire and Lancashire Electric Power Companies," H. F. Parshall.

"Steam Turbines," Professor Auguste Rateau.

"The Testing of Alternating-Current Generators," B. A. Behrend.

"The Continuous-Current Distributing Systems of American Cities," Alexander Dow.

"Protection and Control of Large High-Tension Alternating-Current Distribution Systems" (N. E. L. A. paper), George Eastman.

"Rotary Converters and Motor-Generators in Connection with the Transformation of High-Tension Alternating to Low-Tension Street Current" (Assn. Ed. Illg. Cos. paper), W. C. L. Eglin.

"The Effect of Steam Turbines on Central Station Practice," W. L. R. Emmet.

"The Prussian System of Electric Train Lighting," Herr Carl Roderbourg.

"Commercial Limits of Electric Transmission with Special Reference to Lighting Service," Sig. Ing. Guido Semenza.

"The Superiority of the Alternating Current for Distribution in Large Cities," Dr. G. Stern.

Subject to be announced, Professor S. P. Thompson.

"Measurements of the Energy of Light and Heat Radiation from Electric Light Sources," Dr. W. Wedding.

"Recent Improvements in Electrolytic Meters," Arthur Wright.

"Underground Electrical Construction" (Assn. Ed Illg. Cos. paper), Louis A. Ferguson.

"Storage Batteries" (Assn. Ed. Illg. Cos. paper), Gerhard Goettling.

"American Meter Practice" (N. E. L. A. paper), G. Ross Green.

"Metering Efficiency on Customers' Premises," Caryl D. Haskins.

"Nernst Lamps," Henry Noel Potter.

"Luminous Electric Arcs," Dr. C. P. Steinmetz.

"Distributing Systems from the Standpoint of Theory and Practice," Philip Torchio.

"Electric Transmission and Distribution for Suburban Towns from a General Power Station," Herbert A. Wagner.

SECTION F.—ELECTRIC TRANSPORTATION.

Chairman, Dr. Louis Duncan; secretary, Mr. A. H. Armstrong.

"Theory of the Compensated Repulsion Motor," Ernst Danielson.

"Electrification of British Railways," Philip Dawson.

"Single-Phase Electric Railways," Herr F. J. Eichberg.

"Alternating *vs.* Direct-Current Traction," Professor Dr. F. Niethammer.

"The Booster Machine in Railway Service and Its Most Suitable Control," Professor Dr. Rasch.

"The Electrification of Steam Lines," A. H. Armstrong.

"Some Early Work in Polyphase and Single-Phase Electric Traction," B. J. Arnold.

"General Review of Railway Work," Louis Duncan.

"The Storage Battery in Electric Railway Service," J. B. Entz.

"Braking High-Speed Trains," R. A. Parke.

"Electric Railways," W. B. Potter.

"The History and Development of the Electric Railway," F. J. Sprague.

"Notes on the Electrical Equipment of the Wilkesbarre & Hazelton Railway Company," L. B. Stillwell.

"Central Station Economics and Operation," H. G. Stott.

SECTION G.—ELECTRIC COMMUNICATION.

Chairman, Mr. F. W. Jones; secretary, Mr. B. Gherardi.

"Electric Communications in Spain," Senor Don Julio Cervera Baviera.
"The Present State of Wireless Telegraphy," Dr. J. A. Fleming, F. R. S.
"A New Danger to Lead-Covered Aerial Telephone Cables," John Hesketh.
"Simultaneous Telegraphy and Telephony," Herr Joseph Hollos.
"Telegraphy and Telephony in Japan," Saitaro Oi.
"System for Producing Continuous Electrical Oscillations," V. Poulsen.
"Theory of Telephone Exchange Development," M. G. de la Touanne.
"Modern High-Speed Printing Telegraph Systems," J. C. Barclay.
"Wireless Telegraph Receivers," Dr. Lee De Forest.
"Rapid Telegraphy," Patrick B. Delany.
"The Telephone Problem in Large Cities," Franz J. Dommerque.
"Wireless Telegraphy," Reginald A. Fessenden.
"Loadel Telephone Lines in Practice," Hammond V. Hayes.
"Features of the Dunbar Two-Strand Common Battery Systems," J. C. Kelsey.
"High-Frequency Telephone Circuit Tests," Dr. A. E. Kennelly.
"Problem. Automatic *vs.* Manual Telephone Exchange," Kempster B. Miller.
"Printing Telegraphy," Dr. Louis M. Potts.
"Military Use of the Telegraph, Telephone and Cable," Colonel Samuel Reber.
"Electrolysis of Underground Conductors," Professor George F. Sever.
"Economical Features in Modern Telephone Engineering," L. W. Stanton.
"The Theory of Wireless Telegraphy," John Stone Stone.

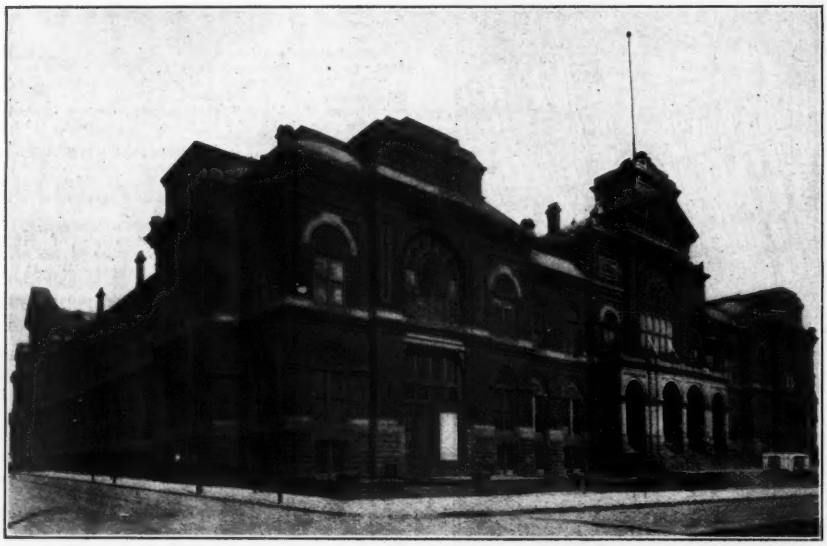
SECTION H.—ELECTROTHERAPEUTICS.

Chairman, Dr. W. J. Morton; secretary, Mr. W. J. Jenks.

"A Contribution to the Radiodiagnostics of Diseases of the Head and of the Brain," Professor Dr. M. Benedikt.
Subject to be announced, Dr. J. Bergonié.
"Some Improvements in Generator Apparatus of High-Frequency Currents," M. le Docteur G. O'Farrill.
"Physico-Therapy of Neurasthenia," Dr. J. Rivière.
"The Ionic Theory as Biological Basis for the Therapeutic Action of Electricity," Professor S. Schatzky.
"Experimental Researches on the Treatment of Tuberculosis by Constant Current," Professor S. Schatzky.
"Recent Advances in Rœntgen Ray Science," Dr. Carl Beck.
"Diagnosis of Calculi by X-Rays" (A. E. T. A. paper), Dr. Russell H. Boggs.
"Radiation in Therapeutics," Dr. Gordon G. Burdick.
"The Nature of the Changes Established in Living Tissues by the Action of Oxidizable Metals at the Anode," Dr. Margaret A. Cleaves.
"Some Observations upon the Treatment of Lupus Vulgaris by Phototherapy, Radiotherapy, and Otherwise" (A. E. T. A. paper), Dr. Charles R. Dickson.
"X-Rays and Radioactive Substances as Therapeutic Agents," Dr. Emil H. Grubbé.
"The Principles of Electrotherapeutics," Dr. T. Proctor Hall.
Subject to be announced (A. E. T. A. paper), Dr. W. J. Herdman.
"Electrotherapeutics," Dr. J. H. Kellogg.
"The Control of Life Phenomena by Electrolytes," Professor Jacques Loeb.
"The Cataphoric Diffusion of Metallic Ions in the Destructive Sterilization of Cancer and Tuberculosis Deposits," Dr. G. Betton Massey.
"Artificial Fluorescence of the Human Organism as a Means of Treating Disease," Dr. W. J. Morton.
"Static Electricity in Chronic Nephritis," Dr. C. S. Neiswanger.
"A Large Fibro-Sarcoma Treated by X-Radiance," Dr. Clarence E. Skinner.
"The Therapeutic Uses of Static Electricity," Dr. Wm. Benham Snow.

The government of the United States, at the petition of the committee of organization, has issued invitations to the various foreign governments to send official representatives to the chamber of delegates of the congress. Up to the present time the following appointments have been announced:

Austro-Hungary: Prof. Charles Zipernowsky. Italy: Prof. Moise Ascoli, Prof. L. Lombardi, Ing. A. Maffezzini. Switzerland: Prof. Ferdinand Weber, Prof. François Louis Schüle. Norway and Sweden: Prof. Svante August Arrhenius. Australian Colonies: John Hesketh, Esq. Brazil: Señor Jorge Newbery. India: J. C. Shields, Esq. Mexico: Señor Rafael R. Arizpe. United States: Prof. H. S. Carhart, Dr. A. E. Kennelly, Prof. H. J. Ryan, Prof. S. W. Stratton, Prof. Elihu Thomson.



THE COLISEUM, OLIVE AND THIRTEENTH STREETS, ST. LOUIS, MO., WHERE THE SESSIONS OF THE INTERNATIONAL ELECTRICAL CONGRESS WILL BE HELD.

The committee of organization has also issued invitations to the various electrical and physical societies all over the world to cooperate and to send delegates to the congress. The following European societies have engaged to cooperate:

The Institution of Electrical Engineers—delegates, Mr. R. Kaye Gray, president; Colonel R. E. Crompton, C. B.; Professor John Perry, F. R. S.; Dr. R. T. Glazebrook, F. R. S.; Mr. H. E. Harrison, B. Sc. B. A.; Mr. W. Duddell, Hon. Secretary of Delegation.

Associazione Elettrotecnica Italiana—delegates, Professor M. Ascoli, president; Professor G. Grassi, vice-president; Professor L. Lombardi, vice-president; Ing. E. Jona.

Oesterrichischer Elektrotechnischer Verein—delegate, Herr Baron Wolfgang Ferstel.

La Société Internationale des Electriciens.

It is expected that joint meetings will be held by the Institution of Electrical Engineers and the American Institute of Electrical Engineers with section A at the Coliseum on Tuesday, September 13, and with section F at the World's Fair on Wednesday, September 14.

In North America, the following societies have engaged to cooperate with the congress:

The Royal Society of Canada—delegates, Professor W. Lash Miller, Professor Howard T. Barnes.

The American Institute of Electrical Engineers, to hold a simultaneous convention and joint sessions with several sections—delegates, Mr. Ralph D. Mershon, Professor M. I. Pupin, Professor C. P. Steinmetz.

The American Physical Society, to hold a simultaneous convention and joint session with section A, September 16—delegates, Professor A. G. Webster, president; Dr. Carl Barus, Professor D. B. Brace.

The American Electrochemical Society, to hold a simultaneous convention and joint sessions with section C, September 13 and 15—delegates, Professor W. D. Bancroft, Professor H. S. Carhart, president; Dr. Louis Kahlenberg.

The National Electric Light Association—delegates, Mr. George Eastman, Mr. G. Ross Green, Dr. F. A. C. Perrine.

The Association of Edison Illuminating Companies—delegates, Mr. W. C. L. Eglin, Mr. L. A. Ferguson, Mr. Gerhard Goettling.

The International Association of Municipal Electricians, to hold a simultaneous convention and joint meeting with section G on September 15—delegates, Mr. W. H. Brandt, Mr. F. C. Mason, Mr. Walter N. Petty.

Pacific Coast Electric Transmission Association—delegate, Dr. F. A. C. Perrine.

The American Electrotherapeutic Association to hold a simultaneous convention and joint meeting with section H, September 15—delegates, Dr. Russell Herbert Boggs, Dr. Charles R. Dickson, Dr. James Herdman.

The United States navy department has appointed as delegate to the congress, Lieutenant-Commander Joseph L. Jayne, U. S. N.

The National Electrical Contractors' Association and the Northwestern Electrical Association will also hold their annual sessions.

At the conclusion of the congress the special train will leave over the Pennsylvania lines at 8 P. M. on Saturday, September 17, arriving at Pittsburg on Sunday, September 18, at 3 P. M. Sunday, September 18, and Monday, September 19, will be spent in Pittsburg; Tuesday, September 20, in Washington, and Wednesday, September 21, in Philadelphia. The party will leave Philadelphia on the same day at 3.30 P. M., arriving in New York two hours later.

The Rapid Transit Subway in New York City.

THE very successful trip of the members and guests of the American Institute of Electrical Engineers on Monday, September 5, through a portion of the rapid transit subway in New York city, renders timely to all of those interested in electric railway progress an article descriptive of the general conditions. The gentlemen under whose direction this remarkable engineering operation has been consummated are of world-wide reputation, and the evidences at hand at the present time point undeniably to the fact that a work has been done of which all may be justly proud.

The official commencement of the work was on March 24, 1900. Active operations did not begin, however, until September 1, owing to the delay in making subcontracts and collecting the plant for the pursuit of the work. From a technical viewpoint, a conspicuous figure has been Mr. William Barclay Parsons, the Chief Engineer of the Board of Rapid Transit Commissioners of the city of New York. Under his able guidance the preliminary plans and details of the system were rapidly laid out, and work of a remarkable magnitude instituted without delay. Since his connection with this engineering undertaking, Mr. Parsons has been further honored by his work in connection with the London underground system and his appointment on the board of Panama canal commissioners.

The greatest of credit must be given to Mr. August Belmont, president of the Interborough Rapid Transit Company—the company which will operate the system—for his executive work and the freehandedness with which he has financed the contracting operations incidental to such a work. He has been ably seconded by Mr. E. P. Bryan, vice-president and general manager of the Interborough Rapid Transit Company. This gentleman has been identified so long with the railroad interests of the country that it is unnecessary here to call attention to his attainments further than to remark that his department has so managed the properties which the Interborough Rapid Transit Company has absorbed since its incorporation as to show records of unprecedented success.

Mr. August Belmont.

Mr. Lewis B. Stillwell, the electrical director, although a young man, had achieved a most enviable reputation for engineering ability of a high order before his connection with the Interborough Rapid Transit Company. Under his direction the work of installing the electrical apparatus, both of the power plant and the railway system, has gone forward with rapidity, and stands to-day the pride of a city which already had been equipped with a complement of generating stations unapproached in any other part of the world.

Other officers of the Rapid Transit Subway Construction Company—the constructing company for the system—and of the Interborough Rapid Transit Company upon whom devolved many of the details of engineering and operation are S. L. F. Deyo, chief engineer, and John Van Vleck, mechanical engineer. Mr. H. G. Stott, who has made a record in handling the Manhattan plant of the Interborough Rapid Transit Company, has also been in charge of the operations of the new power-house at Fifty-ninth street.

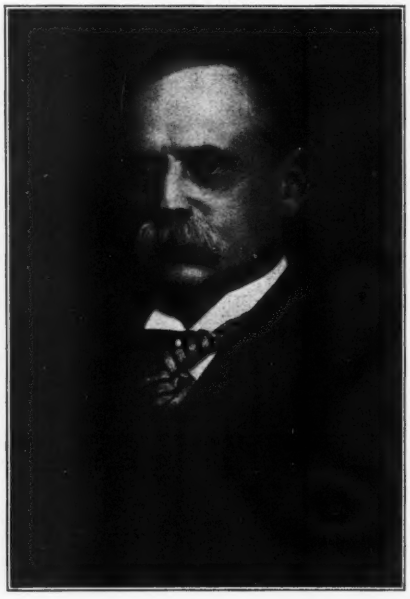
Mr. John B. McDonald, the original contractor, and under whose direction the work has been carried out for the Rapid Transit Subway Construction Company, has had many obstacles to overcome. The attitude which was adopted by many of the labor organizations connected with the building of the system, and the involving of subway workers in troubles which were entirely foreign to this work, have, of course, had much to do with holding back the progress of the undertaking. In spite of these difficulties, however, Mr. McDonald has made remarkable speed, and to his persistent efforts and excellent handling of individuals and organizations is greatly due the present-day completion of the subway system.

The portion of the new Rapid Transit subway which is at the present time practically completed and which may be expected to be in operation in the very near future, includes that part of the proposed subway system which is embraced in contract No. 1. This contract calls for the construction of about twenty-one miles of line, which is made up of a main line about fourteen miles long, extending from the New York City Hall to a terminus near the Kingsbridge station of the New York and Putnam Railroad. From this main line a branch about seven miles long starts about 101st street and drops under the main road, running under the upper end of Central Park, up Lenox avenue and underneath the Harlem river to the intersection of Bronx Park and Boston Road in the Borough of the Bronx.

In addition to the portion of the system covered by contract No. 1, a subsequent contract provides for an extension of the subway from City Hall down Broadway to the Battery and by means of tunnels under the East river to Brooklyn and thence through subway to the Long Island Railroad station at De Kalb avenue. Both the first contract and the subsequent one were awarded to Mr. John B. McDonald and the actual construction was assumed by the Rapid Transit Subway Construction Company, which was organized for the purpose of completing this work.

From the City Hall to 104th street the road is equipped with four tracks and from this point to 145th street with three, this latter section of the line leaving the

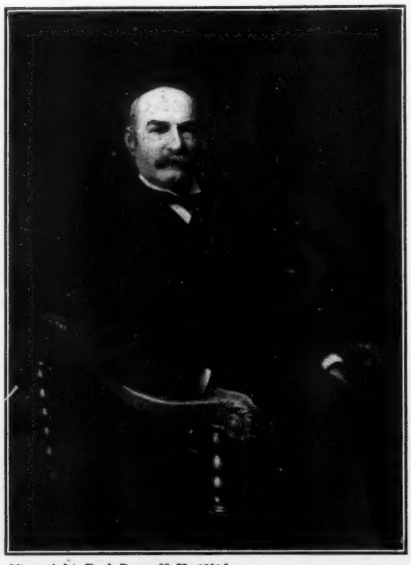
subway for a portion of its length and continuing on the Manhattan valley viaduct constructed for this purpose and again entering the subway. From 145th street to the point where the road reaches the elevated construction there are two tracks and from this point to the end of the line there are three tracks on the elevated structure. The branch line previously mentioned consists of two tracks from the point of its junction with the main line till it reaches Melrose avenue, and the elevated structure on which there are three tracks which continue to the end of the line. The general direction of the main line throughout its length is straight, the single point of exception being at Forty-second street where the subway runs underneath the Park avenue tunnel, and where a sharp right-angle turn



Mr. E. P. Bryan.

is made. At the Brooklyn Bridge station a single-track loop is led underneath the four main tracks and touching at the City Hall station, the principal object of the loop being to afford a convenient means of turning the trains which do not go further down-town and at the same time to effect this result without necessitating the crossing of the four main tracks. There is also a similar loop at the Battery terminus of the road, as at this point two of the four main tracks enter into the two tubes which lead under the East river to Brooklyn and the remaining tracks are connected by a loop built above the tracks leading to the tubes.

The portion of the road, included in the first contract, touches at forty-eight stations, ten of which are on the elevated structure, the remaining thirty-eight being underground. The second portion of the road touches at eight stations, four in Brooklyn, and four on the New York side. The subway stations have in every instance been located as near the surface as possible, although in some instances



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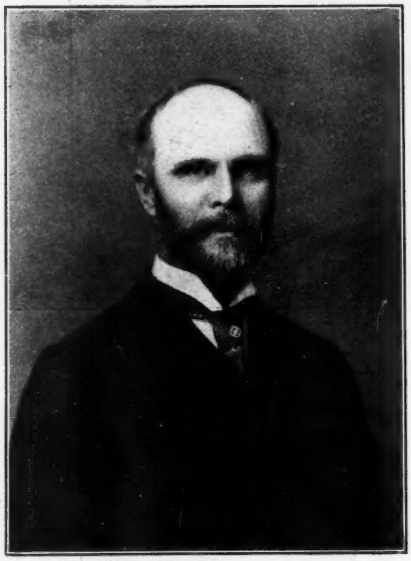
Mr. John B. McDonald.

the station platform is about one hundred feet below the street level, as, for instance, at 167th and 181st streets, and in both of these cases provision is made for passenger elevator service. Where the elevated stations are unusually high as on the Manhattan valley viaduct, moving stair-



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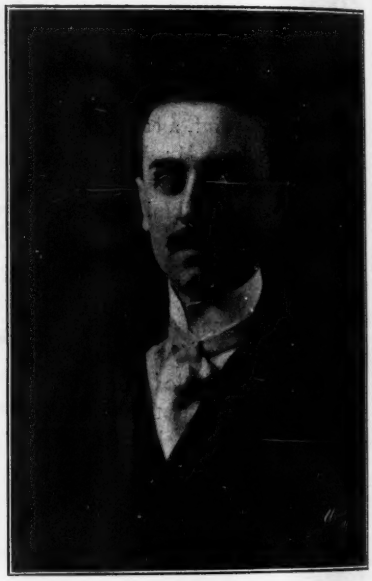
Mr. William Barclay Parsons.

ways are provided for the accommodation of the passengers. There are five stations on the line which are for express train service, namely, the Brooklyn Bridge station; Fourteenth street; Forty-second street, at Grand Central station; Seventy-second street, and Ninety-sixth street. At all of these stations entrance to the express trains is gained from island platforms located between the tracks, which are reached by bridges over the tracks. The heaviest grades on the line are in the tunnels under the Harlem and East rivers, the grade in the East river tunnel being 3.1 per cent, while in the tunnel under the Harlem, the grade is three per cent. The stations are handsomely decorated with terra cotta and tiling, and particular care has been taken to render the identification of the station an easy matter to the passengers. The name is placed conspicuously in a number of places, and in addition to this the combination of colors in the tile finish of the stations has been varied in each case from the bridge to the end of the line, so that it will require but little travel to enable the passenger to recognize at once his particular station.



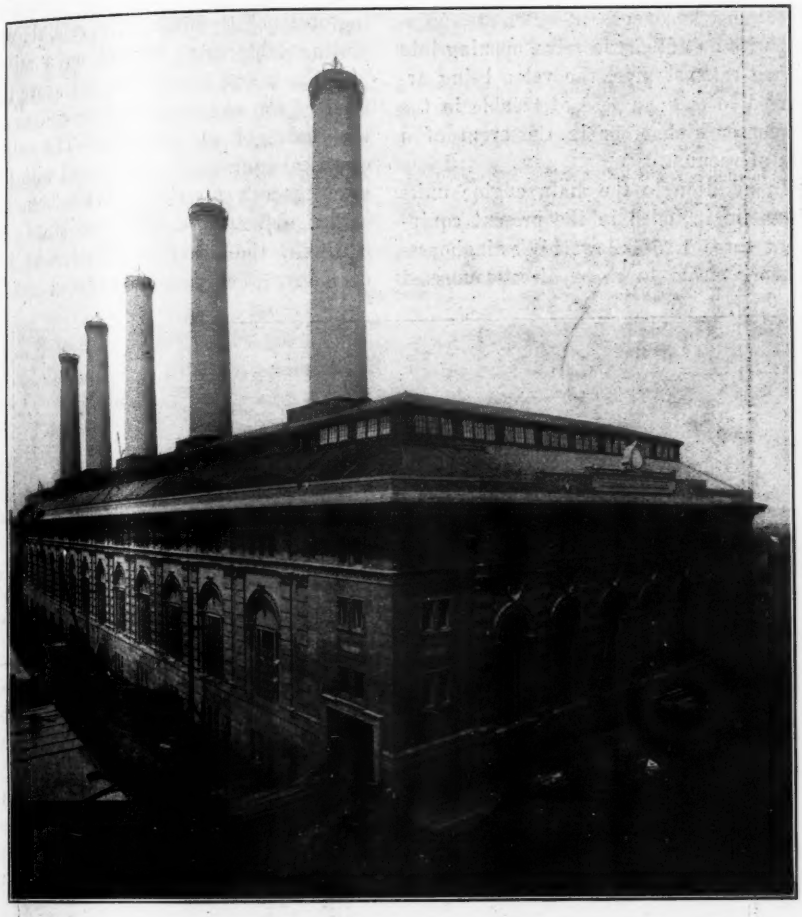
Mr. Lewis B. Stillwell.

The entire interior of the tunnel is painted white, and both the tunnel and stations are lighted by sixteen-candle-power incandescent lamps, and ample ventilation is furnished by means of air shafts in the tunnel and large stairways at the stations. The tunnel is cut through Gneiss rock and is built of concrete and steel, the form of construction varying in different sections. Conduits for carrying the wires are built in the sides of the subway and particular care has been taken to render the entire structure waterproof. The method of constructing the tunnel under the Harlem river is of special interest, as it is unique for this kind of work. A timber dam was built the width of

the tunnel in the bed of the stream and under the water; above this dam was a float hung by chains on which was constructed the upper section of the tunnel, consisting of the castings and concrete covering. When this section was completed it was allowed to sink until it rested on the timber dam; the water was then pumped out and the lower half of the tunnel completed, the outer walls of the timber dam being permanently left in place. With this method of construction it was found that a pressure of from ten to twelve pounds per square inch was sufficient to keep the water from entering the caisson and thus allow the work to be carried on.

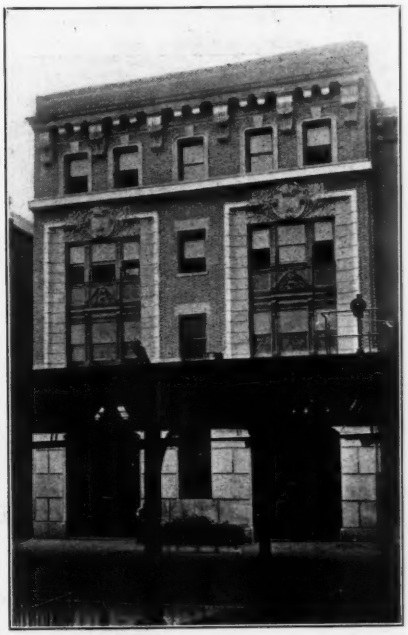
Throughout the entire subway there are eleven sump wells provided at drainage points, from which the water is discharged by means of pumps or air lifts as the particular conditions may warrant. The pumps are in some instances driven by compressed air and in other cases are motor driven.

The road is standard gauge, the rails being the standard A. S. C. E. 100-pound T-rail, laid on five-inch by eight-inch yellow pine ties which are, in turn, laid on ballast consisting of five inches of trap rock. The third rail, which carries the current, is of the standard T cross-section, weighing seventy-five pounds per yard and is protected by planking above and at the side away from the track, the shoe making contact with the rail under the protecting covering. The top of the rail is four inches above the top of the track rail. The current is fed to the line from nine substations, eight of which are in New York and one in Brooklyn.

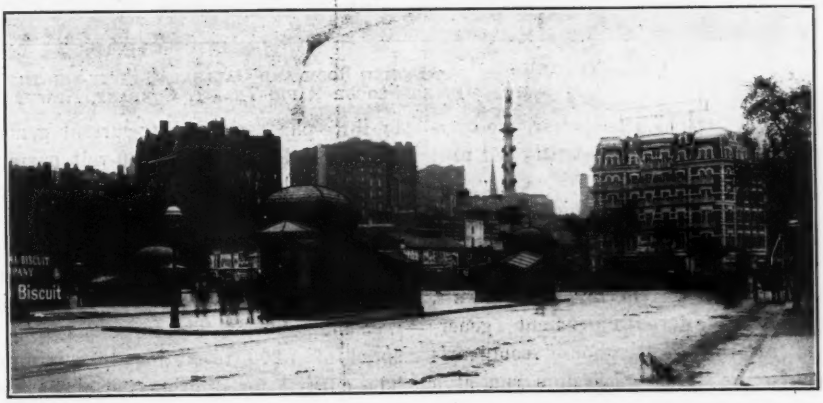


Exterior View of the Fifty-eighth Street Power Station of the Interborough Rapid Transit Company, New York City.

The substations are located as follows: City Hall Place; Nineteenth street; Fifty-third street near Eighth avenue; Ninety-sixth street; 143d street, west of Broadway; 132d street, west; Hillside avenue, west of Eleventh avenue; Fox street, north of Westchester avenue, and Willow Place, Brooklyn. The substations are of the same general type and those for the present necessities are equipped with from four to six rotary converters, there being ample room for additions when it becomes necessary. The rotaries are of the Westinghouse company's manufacture; have a capacity of 1,500 kilowatts and furnish direct current at 625 volts. The three-phase alternating current being brought from the power-house at a tension of 11,000 volts and stepped down by means of 550-kilowatt transformers to about 400 volts before being furnished to the ro-



Typical Substation Building, Interborough Rapid Transit Company, New York City.



Columbus Circle Subway Station, Showing Entrances and Exits.

taries. There is also in each substation a small motor-generator set which furnishes the current for operating the signaling apparatus.

The main power-house of the system is located in the block between Fifty-eighth and Fifty-ninth streets, and Eleventh and Twelfth avenues. The present building being about 700 feet long and 200 feet wide, the boiler and engine rooms running lengthwise of the building, and being separated by an area in which are located the main steam-piping system, below which are the pumps and auxiliaries. The present equipment of the plant consists of about 75,000 rated horse-power, the overload capacity adding about fifty per cent to this figure.

The main units, of which there are nine at present, consist of 7,500 horse-power cross-compound Allis-Chalmers engines, direct-connected to 5,000-kilowatt, three-phase, alternating-current generators of the Westinghouse company's manufacture. The generators run at a speed of seventy-five revolutions per minute and furnish three-phase current at 11,000 volts and twenty-five cycles per second; they are of the revolving field, flywheel type, and are wound with forty poles. Each engine has two horizontal high-pressure cylinders, forty-two inches in diameter, and two vertical low-pressure cylinders, eighty-six inches in diameter, the stroke being sixty inches. The low-pressure cylinders are closely connected to barometric condensers, which are equipped with an automatic valve, opening into a free exhaust pipe, the valve being arranged to open in case of trouble in the condenser system, or in the event of a loss of vacuum.

In addition to the main engine units there are included in the present equipment three 1,250-kilowatt Westinghouse-Parsons steam turbines, direct-connected to three-phase alternating-current generators, which furnish 11,000-volt current at sixty cycles per second. The frequency at which the current is furnished is dictated, in this case, by the fact that the output of the turbine sets is to be used exclusively for lighting purposes in the subway and tunnels. The turbines run at a speed of 1,200 revolutions per minute. The current for exciting the alternators is furnished by five exciter sets of 400 horse-power each, three of these being motor driven, and the two remaining sets consisting of a 400-horse-power compound engine, direct-connected to the generator. The motors which operate the motor-driven exciter sets are run on current furnished at 4,000 volts through step-down transformers.

The switchboard and bus-bar system run almost the entire length of the building on the Fifty-ninth street side, the operating table being located on a raised platform about twenty-five feet above the level of the engine-room floor and about the centre of the building. The entire electrical equipment is in accord with the most modern practice and has been installed under the direction of Mr. L. B. Stillwell, the electrical director of the company. The turbine sets and exciter sets are located in the centre of the engine room opposite the operating table. The boiler house is built to accommodate seventy-two boilers of 6,000 square feet heating surface each, and at the present time sixty boilers are in place. The boilers are of the Babcock & Wilcox manufacture, are arranged in batteries of two each and each boiler has 100 square feet of grate surface, the ratio of heating surface to grate surface being six to one. Each boiler consists of three forty-two-inch drums, twenty-three feet three inches long, and 294 tubes, eighteen feet long and four inches in diameter, the arrangement of tubes being twenty-one high and

A General View of the Engine Room and Galleries, Fifty-eighth Street Power Station of the Interborough Rapid Transit Company, New York City.

fourteen wide. The boilers are built for a pressure of from 175 to 200 pounds. A few of the boilers are equipped with superheaters, both the Foster and Babcock & Wilcox type being used, and also a few mechanical stokers are provided, but the majority of the boilers are arranged for hand firing, as this method is considered preferable by Mr. John Van Vleck, the constructing engineer of this and a number of other well-known plants.

Each battery is provided with four cylindrical steel plate flues which connect to a horizontal flue above the boilers, three batteries, or six boilers, connecting to two such flues. The arrangement of these main flues is such that the hot gases may be passed through economizers should they be provided, or may be discharged directly to the stack. The entire plant, both as regards the boiler and engine room equipment, is divided into sections, each section consisting of two engine units and their auxiliaries, and six batteries of boilers and one smoke stack. The boiler room is divided by a wide aisle, the batteries lying on either side, and the twelve boilers for each section are made up of three batteries on either side of the aisle. There is one common smoke flue leading to the stack into which the batteries are connected from either side. The stacks are of a somewhat novel construction, which appears for the first time in this plant, their design being due to Mr. Van Vleck. They are located in the centre of the sections and in the centre of the passage between the boilers, and are supported by steel columns, six columns carrying each stack. With this method of construction the base of the stack proper is at the level of the bottom of the coal bunker.

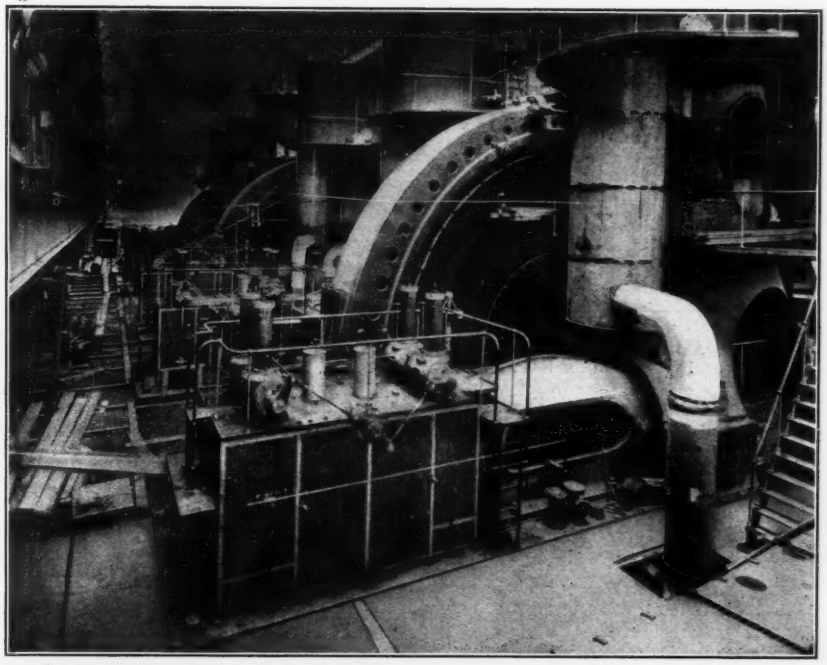
The stacks are fifteen feet in diameter at the top, which is 221 feet above the level of the grates; they are of the Alphons-Custodis construction and weigh about 1,200 tons. At the top of each stack is a metal crown and gallery.

The coal bunkers, which have a maximum storage capacity of 16,000 tons, are built in compartments between the stacks and above the boiler room. The coal is delivered to the boilers from the bunkers by means of pipes, which deposit it on the floor in front of the boilers. Under each boiler row, in the basement, are two ash tracks on which are operated electric hauled ash cars which receive the ashes from the boilers. The coal supply for the plant is most easily obtained from the river, and is delivered by boats at the foot of Fifty-eighth street. After being unloaded and crushed it is received in a small building from which it is carried by a twenty-inch belt conveyer through an underground tunnel to the power-house, where it is received on another twenty-inch conveyer which distributes it to the bunkers. The ash is delivered in the cars previously mentioned, to an ash pocket on the Fifty-eighth street pier, where it is crushed and delivered to scows for removal.

The city water supply is connected to nine storage tanks, located in the basement and under the aisle between the boilers; these tanks are each forty-six feet long, fourteen feet wide, and seven feet six inches deep, the feed being automatically controlled by means of floats, and all tanks being connected by pipes, so as to ensure the supply.

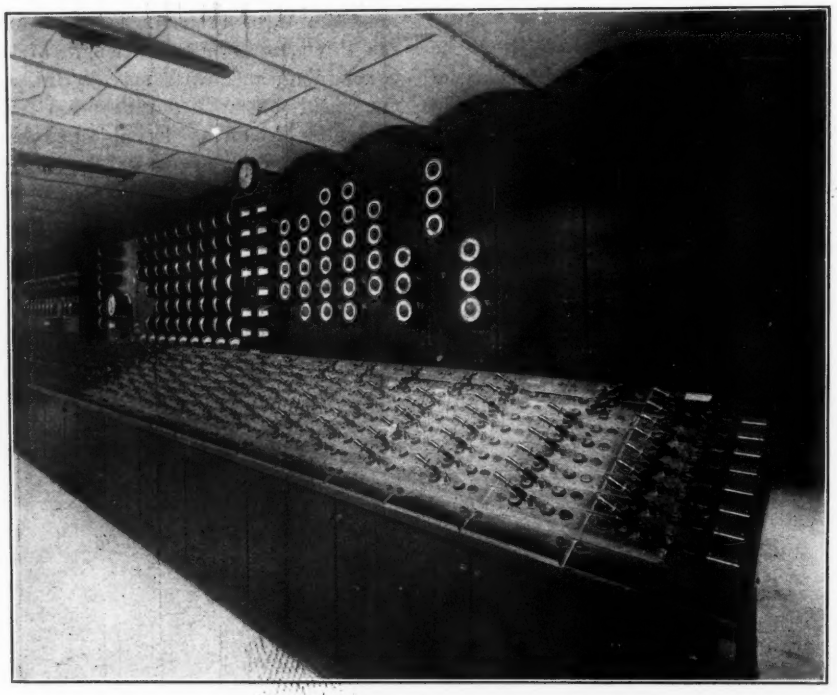
Each engine, as previously stated, is served by six boilers which are connected to a common pipe, which increases from a twelve-inch to a seventeen-inch line. This line is led through the wall between the boiler room and the pipe areaway, and branches into two fourteen-inch pipes which drop down through the areaway, pass through the floor and terminate at the end of a long radius bend in a water catcher, from which a vertical pipe rises through the floor to the throttle valve on the high-pressure cylinder of the engine. The seventeen-inch line is provided with a by-pass arrangement, by means of which either the line from the boilers or the line leading to the two fourteen-inch engine pipes may be connected to a manifold, two such manifolds being provided for each section. Connected to these manifolds are three twelve-inch lines which run throughout the entire length of the power plant, and which may, by this arrangement, be supplied with steam from any group of boilers. The object of these three headers is, of course, to provide against possible shutdown in case of accident, and it will be apparent that with this arrangement any group of boilers may be made to serve any engine unit, and that an accident to a boiler group or even to two of the twelve-inch headers will not cause serious inconvenience. The valves for operating this by-pass and the connections to the manifold have their stems extended through the wall and are operated from a raised gallery in the engine room. Quick-closing valves are provided in the steam line near the boilers, at the manifold and at the engine. The entire high-pressure piping system is installed without expansion or slip joints, and the effect of expansion is taken care of by means of frequent long radius bends.

The auxiliaries for each main engine unit consist of one boiler feed pump, one dry vacuum pump and one circulating water pump, all of which are steam driven. The boiler feed water is taken from the storage tanks through an eight-inch section pipe and either passes through heaters, which are located between the pipes

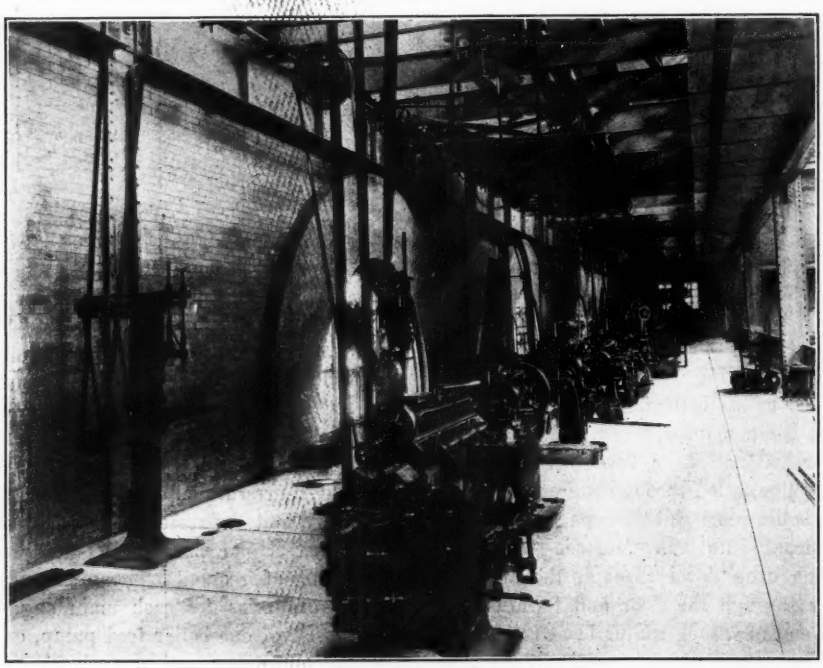


HIGH-PRESSURE SIDE OF 5,000-KILOWATT UNITS, FIFTY-EIGHTH STREET POWER STATION OF THE INTERBOROUGH RAPID TRANSIT COMPANY, NEW YORK CITY.

in the pipe area and which are heated by means of the exhaust from the auxiliaries, and thence to the boilers, or is delivered direct from the tanks to the boilers. The circulating water for the barometric condensers is brought to the plant from the river through a tunnel under Fifty-eighth street and is delivered through a fourteen-inch pipe to the condenser from which the mingled steam and water is discharged, through a tail pipe into the hot well pit from which the water is led to a discharge tunnel which runs above the intake tunnel on Fifty-eighth street and empties into the river. Each condenser, there being two for each engine unit, has a five-inch connection leading to the dry vacuum pump; the two by five-inch lines from the condensers of a single unit running into one eight-inch line, which leads to the pump. The two condenser chambers of each unit are connected by a ten-inch equalizing pipe. The condensers, circulating pumps and dry vacuum pumps were furnished by the Alberger Condenser Company.



SWITCHBOARD AND CONTROL BENCH BOARD, FIFTY-EIGHTH STREET POWER STATION OF THE INTERBOROUGH RAPID TRANSIT COMPANY, NEW YORK CITY.



MACHINE TOOL GALLERY, FIFTY-EIGHTH STREET POWER STATION OF THE INTERBOROUGH RAPID TRANSIT COMPANY, NEW YORK CITY.

One of the most interesting features in connection with this new transportation system is the rolling stock. The cars are fifty-one feet five inches long over the draw bars, and have a seating capacity for fifty-two persons. The seats are arranged very much on the plan of the cars at present in use on the elevated system, there being four pairs of cross seats in the centre of the car, the remaining seats running lengthwise on either side of the central aisle. Each car is mounted on two four-wheeled trucks, the wheel-base on the motor truck being six feet eight inches, while that of the trailer is five feet six inches. The wheels of the motor truck are thirty-three and one-quarter inches in diameter over the tread, and those of the trailer are thirty inches in diameter. The cars are eight feet ten inches wide over the platforms. Every precaution has been taken in the construction of these cars to make them as nearly fireproof as possible, and for this purpose the exterior has been covered with copper along the sides up to the windows, this covering, at the same time, affording a handsome finish and being extremely durable. In addition to these cars the road is also supplied with a number of cars which are constructed entirely of steel. Each motor truck is equipped with two General Electric 69 railway motors, with a normal rating of 150 horse-power which, when operating on a 600-volt circuit, will exert a tractive effort of 3,750 pounds at a speed of twenty miles an hour. The motors are of the nose suspension type, and may be removed from the trucks without necessitating the use of a pit. The cars are equipped with both hand and power brakes, both the apparatus of the Westinghouse Air Brake Company and the Christensen Engineering Company, of Milwaukee, being used. The interior of the cars is handsomely finished in African mahogany. The main aisle between the longitudinal seats, which is four feet four and one-half inches wide, allows ample standing room. It is proposed to operate the local trains with five cars, two of which are to be equipped with motors. The express trains will be made up of eight cars, and in this case three motor cars will be coupled in the trains.

It is understood that the operating schedule for the road will call for a speed of from seventeen to eighteen miles per hour for local service and a speed of about thirty miles per hour for the express service.

The entire road is equipped with the Westinghouse pneumatic block signaling system, which is automatically operated, the current for operating the signal relays being furnished by the small single-phase machines which are located in the substations, as previously described.

STEAM TURBINE GENERATORS.

THE PRINCIPLES OF THEIR DESIGN.

BY B. A. BEHREND.

Electric generators for direct-current connection to steam turbines are characterized by a number of revolutions per minute, several times as great as the speed of reciprocating engines. It is this feature of the steam turbine generators which necessitates a thorough revision of the principles of their design.

The speed of steam turbine depends on the "type" of turbine, according as the pressure, or the velocity, of the steam, or both are subdivided. The turbine of Sir C. A. Parsons, the oldest and best known, subdivides the pressure into many pressure stages, abstracting the energy of the steam in the running blades both as kinetic and potential. The turbine of A. Rateau, subdividing the pressure in the same way as the Parsons's turbine, abstracts the energy of the steam in the running blades as kinetic energy only. The turbine of De Laval, expanding the steam in a nozzle to the condenser pressure, abstracts the energy of the steam as kinetic energy in a single wheel, thus leading to an extremely high number of revolutions per minute, necessitating the use of gears for practical utilization. Using velocity stages instead of pressure stages, a turbine is obtained which is a combination of several De Laval turbines in series. Through the velocity stages lower speeds in revolutions per minute can be obtained, with, however, a high velocity of the steam relative to the blades which is apt to influence unfavorably the life and efficiency of the turbine. Combining pressure stages and velocity stages we obtain the modern Curtis turbine, with formerly two pressure stages and twice three velocity stages, latterly built with four pressure stages and four times two velocity stages. If but one velocity stage were used with each pressure stage, we should obtain again the Rateau turbine. By using one wheel with each pressure stage and conducting the steam twice or several times through the same wheel, we obtain the Riedler-Stumpf turbine.

This digression on steam turbines is necessary to our subject, as the type of the steam turbine determines the speed; *i. e.*, the number of revolutions at which the generator must operate. Thus, for instance, the turbine based on a combination of pressure and velocity stages operates at 500 revolutions per minute for an output of 5,000 kilowatts, whereas the turbine with a large number of pressure stages turns at a speed of 750 revolutions per minute for the same output. It would appear at first sight that the turbine for the higher speed is at a disadvantage, but this would be a grievous error to assume, as the slower number of revolutions is dearly bought at the expense of life and efficiency. In the former case the harmful speed, *viz.*, the velocity of the steam, is high, in the latter case the velocity of the steam is low, and the less harmful speed, expressed in revolutions per minute, is high. In connection with this matter of speed let it be remarked that the reciprocating engine for an output of 5,000 kilowatts turns seventy-five times a minute, against 750 revolutions of our best modern turbines.

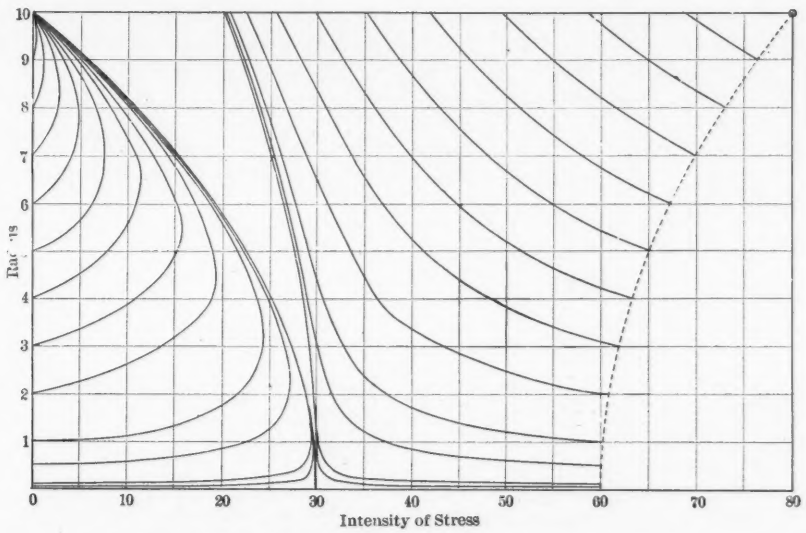


FIG. 1.—CURVES OF STRESSES IN A ROTATING DISC OR ANNULUS.

The mechanical requirements impress their stamp upon the electrical design of the steam turbine generators, and it is to them that we shall first turn our attention. We have tacitly assumed that the generators are alternating-current generators, although many of the principles here discussed apply also to direct-current machines.

A—MECHANICAL PRINCIPLES.

The peripheral speed of the rotating element must be made high for a satisfactory electrical design. It is limited by the strength of the materials used and by the mechanical construction adopted. The theory of the strength of rotating rings and discs and experimental data corroborating it is the starting point of the design of turbine generators.

A mathematical investigation of the strength of rotating annular discs leads to the result that the stresses on the inside are greater than the stresses on the outside of the disc.

The results of this mathematical investigation as worked out by the author in conjunction with Mr. H. A. Burson are represented by the curves of Fig. 1. The abscissæ of the curves represent the stresses, the ordinates the distances from the centre of the disc. The stresses are worked out for a disc of uniform thickness, and the radial and tangential stresses are separated. The curves to the left of the figure 30 are the radial stresses, the curves to the right of the radial stress line 10-30 are the tangential stresses. For our present purpose we need consider only the tangential stresses, as they exceed by many times the radial stresses.

For a solid disc the maximum tangential stress is in the centre and its relative value may be obtained from our curves as thirty.

The relative tangential stress at the circumference is twenty; *i. e.*, two-thirds the stress in the centre. It is on this account that rotating discs, in flying to pieces, "burst," by breaking first in the centre. This theory has been proved by the author with lead discs which were run at such high speed as to show material deformation. The thickness of the disc after the test thus becomes a criterion of the radial plus the tangential stresses, as the lateral contraction is directly proportional to the sum of these stresses.

A small perforation at the centre doubles the stress in this point, as may be seen at a glance from the curves. The reason consists in the fact that, with the presence of such a hole, the total stress

must be in the form of tangential stress, as the radial stress in a surface must be zero.

Increasing the inner radius the maximum stress increases from sixty to eighty for a ring indefinitely thin. Hence, a hoop of the same diameter as the outside diameter of the disc is subject to a stress which is greater than the maximum stress inside an annulus. Therefore, we may lay down the rule that in any disc with a hole inside the peripheral speed should not exceed the safe speed for a hoop of the same diameter; then the stresses in the disc will not exceed the stresses in the hoop.

Simple mathematical calculation shows that the stress ζ in a hoop is

$$\zeta = m\, v^2 \qquad (1)$$

where m is the mass of unit volume and v the peripheral speed; all dimensions in centimetres, stress in grammes per square centimetre.

From this formula it follows that for a peripheral speed of 20,000 feet per second the stress is 11,000 pounds per square inch, and as the elastic limit for manganese bronze is 30,000 pounds per square inch, and for nickel steel as high as 50,000 pounds per square inch, a peripheral speed of 20,000 feet per minute will be feasible, irrespective of the diameter used. By properly designing the rotating element even higher speeds may be used. Properly shaped discs, as De Laval's turbine discs, are run at 80,000 feet per minute peripheral speed, as here the elements toward the centre of the disc support the outside elements.

Having thus found an approximate speed limit, which yet permits of the use of hoops and bands as may be needed for holding the coils, we proceed to consider the calculation of the diameter of the shaft. Twenty years ago we were taught that with the increase in speed the diameter of shafts transmitting a certain amount of power could be diminished. This is true only as long as vibrations of the shaft between bearings are of no moment and not likely to occur. In turbine generators, however, the vibrations have to be guarded against and that speed has to be carefully calculated, at which the natural period of transverse vibration of the shaft loaded with the rotating element is equal to the period of the impulses given to the shaft by the centrifugal force acting on the slightly bent shaft. This is a highly interesting dynamical problem, which was investigated over thirty years ago by the ingenious Rankine, and which has since been carefully studied by Professors Osborne Reynolds, Dunkerley, Foeppl, and Stodola. At this speed of synchronism or resonance between the forced and the natural periods of vibration, the shaft vibrates violently and stable operation is impossible. Operating the shaft at a speed slightly below or slightly above this speed, stable operation is again possible. The speed at which safe operation is impossible we call the *critical speed.*

Mathematical analysis for turbine rotors leads to the following equation:

$$\Omega_0^2 = \frac{KEI}{m\, l^3} \qquad (2)$$

In this equation Ω_0 is the angular velocity at the critical speed; E, Young's modulus of elasticity; I, the moment of inertia of the shaft in relation to bending; m, the mass of the rotating element; l, the distance between bearings, and K a constant whose value is about seventy-five for turbine generators. The great importance of the proper determination of the diameter of the shaft, aside from jeopardizing safe operation, lies in the fact that the magnetic circuit and the ventilation closely depend upon the space occupied by the shaft. Having thus described the most essential mechanical conditions to be satisfied, we turn our attention to the discussion of the electrical principles underlying the design of turbine generators.

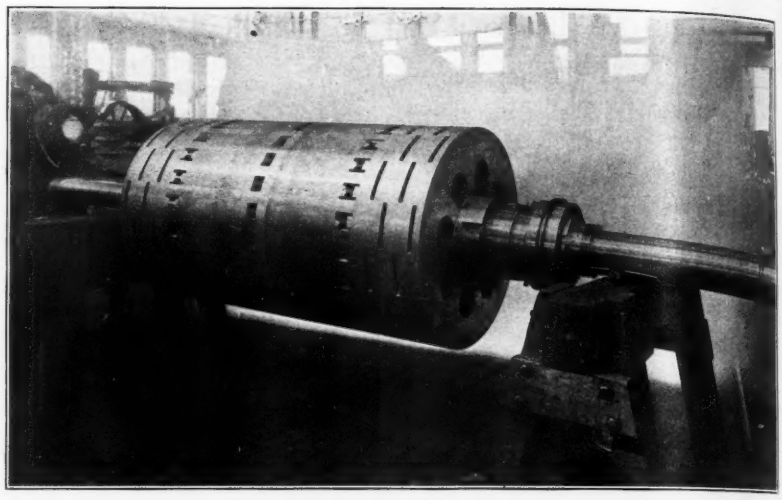


FIG. 2.—REVOLVING FIELD OF TWO-POLE, 1,000-KILOWATT, TWENTY-FIVE-CYCLE GENERATOR.

B—THE ELECTRICAL PRINCIPLES.

The principles which determine the design of alternating-current generators of the slow-speed type are essentially the same in *kind,* though not in *degree,* as those underlying the design of turbine generators. We distinguish between the *main* characteristics, *viz.,* the regulation and the thermal conditions, as produced by the losses in the machine, and finally the ventilation and windage.

FIG. 3.—CORE OF REVOLVING FIELD OF TWO-POLE, 1,000-KILOWATT, TWENTY-FIVE-CYCLE GENERATOR.

REGULATION.

As to the regulation of the turbine generator the same general principles hold

which the author has laid down in his various papers, and latterly again in his Institute paper presented in 1903. The high peripheral speed leads to pole-pitches of fifty and sixty inches on large twenty-five-cycle generators, and to twenty and thirty inches on sixty-cycle generators. To take care of the great armature reaction thus produced, the air-gap of the turbine generators must be made considerably larger than on slow-speed machines. The 3,500-kilowatt generator at the World's Fair running at seventy-five revolutions per minute has an air-gap of 0.5 inch, whereas a 3,500-kilowatt generator running at 750 revolutions per minute for the same regulation has an air-gap of nearly two inches. As in the case of slow-speed generators, the regulation curves for zero power-factor should be carefully calculated, and from them the regulation curves for higher power-factors should be deduced.

THERMAL CONDITIONS.

While the core and copper losses of turbine generators are slightly smaller than those of the slow-speed type, yet it is far more difficult to get rid of the heat produced by them on account of the considerably smaller radiating surfaces of the turbine generators. Low densities in the iron and copper are necessary and the most careful ventilation of the core and of the field winding becomes essential. To this point a great deal of care must be devoted.

VENTILATION AND WINDAGE.

To reduce the loss produced by windage or air friction at the high speeds, the rotating element should preferably be made cylindrical, as, for instance, the rotor of a 1,000-kilowatt, two-pole, twenty-five-cycle generator, represented in Fig. 2. Fig. 3 represents the core of the revolving field before the windings have been put in. This picture clearly shows some of the characteristic details of high-speed revolving fields. The plane of the field coils is placed radial, so that the centrifugal force acts normal to the surface of the flat copper strip. The field coils, being embedded in slots, are thus secured against shifting sideways. They are retained in the slots by bronze wedges, as is clearly shown in Fig. 2. The ordinary construction of field magnets is not well adapted to high-speed work, as on account of the plane of the coils and the direction of the centrifugal force not falling together, the centrifugal force has an unbalanced component normal to the plane of the coils which is liable to break the coil or make its turns slide over the poles.

Fig. 4 shows a picture of a 1,000-kilowatt, 6,600-volt, three-phase, twenty-five-cycle, 1,500-revolutions-per-minute generator, of which Figs. 2 and 3 show the details of the rotor. In order to take care of the losses in the stator, it is necessary and desirable to use a blower as on air-blast transformers.

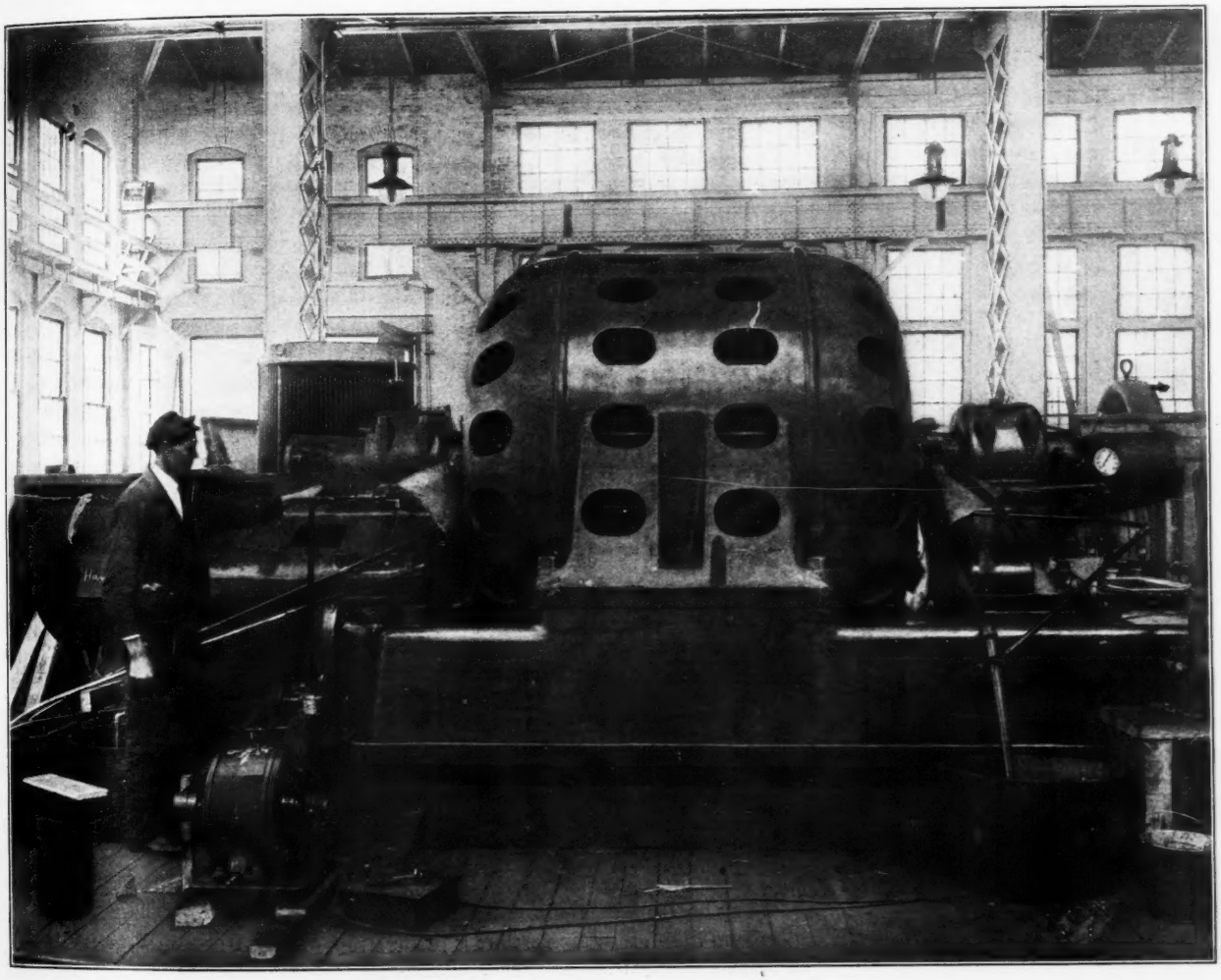


FIG 4.—1,000-KILOWATT, TWO-POLE, TWENTY-FIVE-CYCLE GENERATOR, 6,600 VOLTS, THREE-PHASE, 1,500 REVOLUTIONS PER MINUTE.

COMPARATIVE WEIGHTS AND COSTS OF GENERATORS AT DIFFERENT SPEEDS.

It is interesting to compare the weights of alternating-current generators for the same output at different speeds. At first sight it would seem as though the weight

of the machine decreased in proportion with the increase in speed. All engineering problems, however, are problems of maximum and minimum, and hence it may be expected a priori that there must be a speed at which the weight of the generator is a minimum, *i. e.*, above and below this speed the weight increases. Fig. 5 represents in form of a curve the weights of a 1,000-kilowatt, twenty-five-cycle generator at different speeds, indicating that the weight of a machine of this capacity is a minimum at 750 revolutions per minute, and that a 1,000-kilowatt generator at 1,500 revolutions per minute weighs as much as a 1,000-kilowatt generator at 250 revolutions per minute, a fact which is certainly most interesting. Increased speed, then, may mean increased weight, and, as increased speed also involves greater care and better material, increased speed may often mean greatly increased cost.

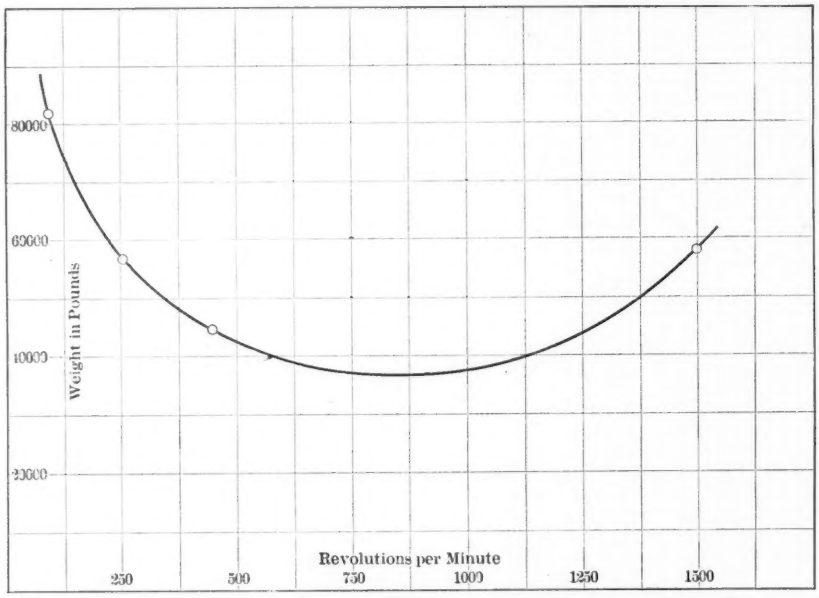


FIG. 5.—CURVE SHOWING COMPARATIVE WEIGHTS OF 1,000-KILOWATT, THREE-PHASE, TWENTY-FIVE-CYCLE GENERATORS AT DIFFERENT SPEEDS.

The Convention of the Ohio Society of Mechanical, Electrical and Steam Engineers.

The Ohio Society of Mechanical, Electrical and Steam Engineers will hold its next meeting at Canton, Ohio, on the 18th and 19th of November, 1904. Mr. Richard H. Probert is president of the society, and Mr. Corwin J. Miller, secretary.

Telephone Train Despatching

It has been announced on good authority that the Northern Pacific Railroad will very shortly let contracts which will revolutionize the present system of train despatching. The plan will be nothing more than the substitution of the telephone for the telegraph on long and important stretches of the St. Paul-Portland route.

Electric Lighting at St. Petersburg and Moscow.

A recent report by the electric light company operating in St. Petersburg and Moscow shows that during seven months and a half the output of this company has increased by over 21,000 on sixteen-candle-power lamps at St. Petersburg and by nearly 40,000 at Moscow. During the last year the increase at St. Petersburg was something over 17,000 and at Moscow less than 29,000. The total sale of power for the time mentioned was 9,679,739 kilowatt-hours, of which 4,541,703 kilowatt-hours were consumed in St. Petersburg. The distributing system at St. Petersburg comprises 2,492 metres of low-tension cables and 15,365 metres of high-tension cables. There are seventeen transformer stations with a total rating of 1,002 kilowatts. At Moscow the low-tension cables have a length of 12,219 metres and the high-tension cables of 15,744 metres. There are fifty-seven transformers with an aggregate rating of 796 kilowatts. A dividend of two and one-half per cent was declared as against one and one-half per cent the year before.

The report urges the purchase of three steam turbines, two of which will be installed at Moscow and one at St. Petersburg, each of the turbines to be rated at 2,250 horse-power. The increase in the equipment at the Moscow station will be necessitated by a contract into which the company has entered with the municipal authorities. By this the station will furnish current for the electric railways. Including these two turbines there will be twelve generating sets at the Moscow station, with an aggregate power of 12,000 kilowatts. At St. Petersburg there are nine units, aggregating 7,500 kilowatts.

New Electrical Transmission for a Cotton Mill.

The Blackstone Manufacturing Company, of Blackstone, Mass., will soon be operating its new factory and power-house. The power plant, on the bank of the Blackstone river, is a one-story brick building divided into three parts, one for water-wheels, one for boilers, and the third for a steam engine. A compound engine will be direct-connected to a Westinghouse three-phase generator of 100 horse-power. The revolving field weighs 32,700 pounds, and has a diameter of thirteen feet five inches. The wheel is cast in one piece, and has a rim bolted on the casting for the field coils. Alternating current of 440 volts will be delivered to the mill, 600 feet from the power-house. Four thirty-six-inch water-wheels are direct-connected to an 840-kilowatt generator making 200 revolutions per minute and developing 1,120 horse-power. Both generators are designed for fifty per cent overload, and the units are arranged so that they can be driven together or separately. The motors, of which there are sixteen, are located to attain the best economy. In addition to the four thirty-six-inch water-wheels there is a twenty-inch turbine of 100 horse-power, which will be employed in generating current for lighting when there is no load for the other turbines or the steam engine. This is independent of the other power units. Current will be transformed from 440 to 110 volts for lighting. The available horse-power at the point where the mill is located is 1,500 in the winter time, with a fall of thirty-two feet, and 600 during the summer, with an average for the year of about 1,000.

Large Power Plant for Southern California.

A syndicate of southern capitalists has projected a plan to harness the waters of the San Joaquin river in California and generate electricity for the surrounding agricultural and mining sections. A tunnel three miles long through the mountains will supply 500 cubic feet of water per second, and assure the development of 15,000 horse-power. It is stated that the syndicate has secured control of the Fort Miller Power Company, organized in 1900. The undertaking will involve the expenditure of about one million dollars.

THE BRITISH ASSOCIATION 1904 MEETING AT CAMBRIDGE, ENGLAND.

BY JOHN B. C. KERSHAW.

The seventy-fourth annual meeting of the British Association for the Advancement of Science was opened on Wednesday evening, August 17, by an address from the Rt. Hon. Arthur James Balfour, president-elect, in the Guild Hall, of Cambridge, England.

Mr. Balfour had chosen as subject of his presidential address, "Reflections Suggested by the New Theory of Matter," and with the electron theory as his text, he discoursed for over an hour to an audience of over 2,000 persons upon the inability of mere physical science to explain the mysteries of matter and of the universe. It is, of course, impossible in this brief report to deal at length with the presidential utterance, but the following extracts from the address will be of special interest to readers of the ELECTRICAL REVIEW, and will show the drift of Mr. Balfour's reasoning and argument. It will be observed that Mr. Balfour used the term "monad" where a modern electrician would have employed the term "electron."

"To-day there are those who regard gross matter, the matter of every-day experience, as the mere appearance of which electricity is the physical basis; who think that the elementary atom of the chemist, itself far beyond the limits of direct perception, is but a connected system of monads or sub-atoms which are not electrified matter, but are electricity itself; that these systems differ in the number of monads which they contain, in their arrangement, and in their motion relative to each other and to the ether; that on these differences, and on these differences alone, depend the various qualities of what have hitherto been regarded as indivisible and elementary atoms; and that while in most cases these atomic systems may maintain their equilibrium for periods which, compared with such astronomical processes as the cooling of a sun, may seem almost eternal, they are not less obedient to the law of change than the everlasting heavens themselves.

"It is but a century ago that the title of an ether to a place among the constituents of the universe was authentically established. It seems possible now that it may be the stuff out of which that universe is wholly built. Nor are the collateral inferences associated with this view of the physical world less surprising. It used, for example, to be thought that mass was an original property of matter, neither capable of explanation nor requiring it; in its nature essentially unchangeable, suffering neither augumentation nor diminution under the stress of any forces to which it could be subjected; unalterably attached to, or identified with, each material fragment, howsoever much that fragment might vary in its appearance, its bulk, its chemical or its physical condition.

"But if gross matter be a grouping of atoms, and if atoms be systems of electrical monads, what are these electrical monads? It may be that, as Professor Larmor has suggested, they are but a modification of the universal ether, a modification roughly comparable to a knot in a medium which is inextensible, incomprehensible and continuous. But whether this final unification be accepted or not, it is certain that these monads can not be considered apart from the ether. It is on their interaction with the ether that their qualities depend; and without the ether an electric theory of matter is impossible.

"Surely we have here a very extraordinary revolution. Two centuries ago electricity seemed but a scientific toy. It is now thought by many to constitute the reality of which matter is but the sensible expression.

"But if the new theories be accepted these views must be revised. Mass is not only explicable, it is actually explained. So far from being an attribute of matter considered in itself, it is due, as I have said, to the relation between the electrical monads of which matter is composed and the ether in which they are bathed. So far from being unchangeable, it changes, when moving at very high speeds, with every change in its velocity.

"Considerations like these, unless I have compressed them beyond the limits of intelligibility, do undoubtedly suggest a certain inevitable incoherence in any general scheme of thought which is built out of materials provided by natural science alone. Extend the boundaries of knowledge as you may; draw how you will the picture of the universe; reduce its infinite variety to the modes of a single space-filling ether; retrace its history to the birth of existing atoms; show how under the pressure of gravitation they became concentrated into nebulæ, into suns, and all the host of heaven; how, at least in one small planet, they combined to form organic compounds; how organic compounds became living things; how living things, developing along many different lines, gave birth at last to one superior race; how from this race arose, after many ages, a learned handful, who looked round on the world which thus blindly brought them into being, and judged it, and knew it for what it was—perform, I say, all this, and, though you may indeed have attained to science, in nowise will you have attained to a self-sufficing system of beliefs. One thing at least will remain, of which this long-drawn sequence of causes and effects gives no satisfying explanation; and that is knowledge itself. Natural science must ever regard knowledge as the product of irrational conditions, for in the last resort it knows no others. It must always regard knowledge as rational, or else science itself disappears. In addition, therefore, to the difficulty of extracting from experience beliefs which experience contradicts, we are confronted with the difficulty of harmonizing the pedigree of our beliefs with their title to authority. The more successful we are in explaining their origin, the more doubt we cast on their validity. The more imposing seems the scheme of what we know, the more difficult it is to discover by what ultimate criteria we claim to know it.

"Here, however, we touch the frontier beyond which physical science possesses no jurisdiction. If the obscure and difficult region which lies beyond is to be surveyed and made accessible, philosophy, not science, must undertake the task. It is no business of this society. We meet here to promote the cause of knowledge in one of its great divisions; we shall not help it by confusing the limits which usefully separate one division from another. It may perhaps be thought that I have disregarded my own precept—that I have wilfully overstepped the ample bounds within which the searchers into nature carry on their labors. If it be so, I can only beg your forgiveness. My first desire has been to rouse in those who, like myself, are no specialists in physics, the same absorbing interest which I feel in what is surely the most far-reaching speculation about the physical universe which has ever claimed experimental support; and if in so doing I have been tempted to hint my own personal opinion that as natural science grows it leans more, not less, upon an idealistic interpretation of the universe, even those who least agree may perhaps be prepared to pardon."

Mr. Balfour's address was listened to with the deepest attention by his large audience, and the spectacle presented by the Prime Minister of England discoursing upon the largely hypothetical character of modern physical science, and of

what is called "knowledge" of the universe, to an audience which included Kelvin, Thomson, Rayleigh, Lodge, Larmor, and others equally well known in the ranks of European science, was striking in the extreme, and one not easily to be forgotten.

Of the addresses which were delivered by the presidents of the various sections on Thursday morning, August 18, only that of the Hon. Charles A. Parsons, F. R. S., of steam-turbine fame, can be specially dealt with. As president of the engineering section, Mr. Parsons had chosen for his subject, "Invention"—and he dealt with the difficulties placed in the path of the inventor, by ancient superstitions and by modern laws.

Although American patent law and procedure differ from English in many respects, some of the obstacles to progress touched upon by Mr. Parsons are common to both countries. In tracing the usual course of development in the case of any great improvement—the author took as example the internal combustion engine, and followed the history of its invention and development from the early date of 1680, when Huygens first experimented with explosive gases in confined spaces, down to the present time. Mr. Parsons had no difficulty in proving that had some of the disadvantages of our present system of patenting and developing inventions been removed, a much earlier arrival of the internal combustion engine at its existing stage of utility would have been attained. Discussing the reforms needed in English patent law procedure, the author pointed out that some very important problems, affecting the welfare of mankind generally, are at present neglected, because, to use a colloquial expression, inventors believe there is no money in them.

Two examples of such problems were given by the author:—namely, those of aerial navigation, and deep level mining. After discussing in detail the methods which might be employed in attacking the latter problem, Mr. Parsons gave estimates (based on actual experience on the Rand gold-fields) of the time and expenditure envolved in serious attempts to penetrate deeply into the earth's crust.

The author then discussed the reforms in patent law, which would be necessary to render such investigations possible and likely to be remunerative to those providing the necessary funds, and he pointed out that an alteration of the law respecting extension of the life of patents in particular cases, was urgently required.

One of the chief objections raised by the Privy Council against the extension of patents in England has rightly been that undue prolongation is unfair to the British public, seeing that abroad no prolongations are granted. Therefore, if the duration of patents for important matters is to be extended at home it must also be extended abroad. In other words, such prolongations, to be effective, should necessarily extend to other countries. They should be international, and concurrent in all the countries interested.

One possible solution of this difficult question would be to place such matters under the jurisdiction of a central international committee, who would have the apportionment of the life and privileges of patents and of the extension or curtailment of their duration, according to their handling by the owners. I would ask, why has a patent a life of only fourteen to sixteen years, while copyright is for forty-two years? Why has a pioneer company making a railway under act of Parliament generally rights forever unless it abuses its privileges, or the requirements of the district necessitate the construction of competing lines, while a patent has in comparison a life of infinite shortness?

The Prime Minister, who was present, in proposing the customary vote of thanks to Mr. Parsons for his address, took up this question of international agreement as regards patent law—and caused some laughter by his remark, that "international agreement" was a plant of very slow growth—and that little progress in the reform of patent law could be made until it was more developed than was at present the case.

At the conclusion of his remarks, Mr. Balfour introduced Professor Schröter, of Munich, who, in the name of the German Society of Engineers (numbering 19,000 members), presented the Grashof gold medal to Mr. Parsons for his valuable work in the development of the steam turbine.

The afternoon session of the engineering section was devoted to a popular lecture by Mrs. Hertha Ayrton upon the "Origin of Sand Ripples." This lecture was illustrated by beautiful experiments showing the action of waves upon sand contained in large troughs, and it attracted a crowded audience.

FRIDAY, AUGUST 19.

The morning session of Friday was devoted in the engineering section to papers dealing with the various problems presented by the internal combustion engine. Mr. Dugald Clerk, one of the English pioneers in this branch of engineering, opened with a paper upon "Flame Temperatures in Internal Combustion Motors," and described a new type of engine, designed for reducing the temperature of the gases during the explosion, and yet obtaining a higher thermal efficiency in the operation of the engine. This effect is obtained by compressing the air admitted with the combustible gas, either by means of a separate air compressor, or by the energy of the exhaust gases. The figures given by Mr. Clerk showed thermal efficiencies raised from 28.7 to 32.5 per cent, and from 27.7 to 34.4 per cent by this method of construction and operation; and his firm, the National Gas Engine Company, of the United Kingdom, has decided to build some large gas engines under the patents granted to Mr. Clerk for this improvement.

Professor Dixon, of Victoria University, Manchester, followed with a lecture upon "The Specific Heats of Gases at High Temperatures," and described the methods used and results obtained by him in recent work upon this subject, and upon the allied ones of flame velocity, and of the character of the physical and chemical changes in explosive gas mixtures after ignition at one or more points in their mass.

As regards the specific heats, Professor Dixon's researches have led him to the conclusion that the values for both air and carbonic acid rise steadily with increased temperature, and that in the case of carbonic oxide, dissociation occurs at a comparatively low temperature (about 2,000 degrees). This dissociation vitiates any calculations for the specific heat of this gas at temperatures near this limit. With steam dissociation phenomena only commence at a much higher temperature, a fact which is not without significance in the choice of a gas-producer plant intended to supply gas for motor purposes.

The third paper on the general subject of gas engines was contributed by Professor E. Hopkinson, of the Cambridge University Engineering Laboratory, and related to a "New Method of Testing the Thermal Efficiency of These Engines." The method, briefly, is the very old one of making up a heat balance for the work of the engine, and the novelty lies in the apparatus adopted for measuring the heat lost in the exhaust gases. These gases are cooled by a new form of calorimeter, in which a thin sheet of water is broken up into fine spray by the kinetic energy of the exhaust gases, and the heat of the

latter is in this manner completely transferred to the water. In the discussion which followed the reading of Professor Hopkinson's paper, it was pointed out that this method had already been applied with success to the determination of gas engine efficiencies both in Germany and the United States, and that owing to its suitability for testing the performance of large gas engines, its use was likely to become general.

Sir Andrew Noble, Professor Schröter, of Munich, Professor Hudson-Beare, Lord Kelvin (better known abroad as Sir William Thomson), Professor Dixon and others joined in the discussion of the various points raised in the three papers, and the theory of gas engine construction and working certainly received more attention from the distinguished men present at the meeting than has been devoted to the subject for many years.

Mr. Dugald Clerk, in the course of his paper, exhibited a very large number of gas engine diagrams and photographs, and stated, incidentally, that a 5,000-horse-power gas engine plant, consisting of seven 700-horse-power units, will shortly be working at Middlesborough, in Yorkshire, thus proving the use of large gas engines to be making considerable progress in the North of England.

On Friday evening a public lecture, illustrated by lime-light views, was delivered by Professor George Darwin (son of the famous Charles Darwin), upon "Ripple-Marks and Sand-Dunes," in the theatre, to an audience of nearly 1,800, and this lecture had to be repeated later in the association week, for the benefit of those who could not gain admission at the first delivery.

Saturday, August 18, was devoted to excursions to places of interest around Cambridge—those to Sandringham (the King's country residence) and to Ely being the most popular and the most numerously patronized.

Limit of space will not admit of any further detailed account of the proceedings of section C during the remainder of the association meeting, but the following list of papers to be read at the sittings of this section for August 22, 23 and 24 may prove useful to readers of the ELECTRICAL REVIEW:

MONDAY, AUGUST 22.

1. "The Use of Electricity on the North Eastern Railway and on Tyneside."—C. H. Merz and W. McLellan.
2. "Electricity from Water Power."—A. A. Campbell Swinton.
3. "Energy Losses in Magnetizing Iron."—W. M. Mordey and A. G. Hansard.
4. "Testing Alternating-Current Induction Motors by a Hopkinson Method."—Dr. W. E. Sumpner and R. W. Weeks.
5. "Large Bulb Incandescent Lamps as Secondary Standards of Light."—Professor J. A. Fleming.
6. "Some Investigations on the Ten-Candle-Power Harcourt Pentane Lamp Made at the National Physical Laboratory."—Clifford Paterson.
7. "Distribution of Magnetic Induction in Multipolar Armatures."—W. M. Thornton.

TUESDAY, AUGUST 23.

1. "The Control of the Nile."—Major Sir Hanbury Brown, K. C. M. G.
2. "A Universal Testing Machine of 300 Tons for Full-Sized Members of Structures."—J. H. Wicksteed.
3. "The Effect of Rapidly Alternating Stresses on Structural Steels."—Professor J. O. Arnold.
4. "Mechanical Tests of Alloy Steel. A Magnetic Alloy Containing No Iron."—R. A. Hatfield.
5. "A New Process for the Protection of Iron and Steel from Corrosion."—S. Cowper-Coles.
7. "Indicator Tests on a Small Petrol Engine." With experimental demonstration. —Lecture by Professor H. L. Callendar.

WEDNESDAY, AUGUST 24.

1. Report of the Mersey Tidal Régime Committee.
2. "Side Slip in Motor Cars." Illustrated with a model.—H. Darwin and V. C. Burton.
3. "The Electrical Conductivity of Certain Aluminum Alloys as Affected by Exposure to London Atmosphere, and a Note on Their Microstructure."—Professor E. Wilson.
4. "Proposed Barrage of the River Thames."—J. Casey.
5. "Testing Alternating Motors by Direct Current."—W. Cramp.
6. "The Action of Lightning Strokes on Buildings."—Killingsworth Hedges.

In bringing this report of the Cambridge 1904 meeting of the British Association to a close, it may be remarked that the attendance of members and associates has been much above the average of recent years, 2,711 names having been registered up to Thursday, August 18. The double draw of an old university town as meeting place, and the Prime Minister as president, has no doubt helped to make the meeting a popular one.

Whether certain reforms in the procedure of the sections which have been introduced this year for the first time have had any effect in checking that decline of the meeting in influence and importance which has been very manifest in recent years, it is yet too early to judge, and the meeting of 1905, in South Africa, will not help to solve the problem, for special causes will again be at work to influence the normal figures for the attendance.

That the meeting of 1904, at Cambridge, has been one of the most successful of those held in recent years is, however, a fact which can not be disputed, and the officials of the association will no doubt be cheered by this success, and will argue from it that the association is about to renew its youth, and to enter upon a period of increased influence and prosperity.

Machinery Exposition in Spain.

Julius G. Lay, consul general of Barcelona, Spain, writes that up to July 18 no American firms had applied for space at the exposition of mining and hydraulic machinery and appliances to be held during September and following months at Barcelona, Spain. Large mining projects are in course of development in that country, and American neglect has permitted German and English machinery to practically monopolize the field. The exhibition here noted is to make known to capitalists the wealth contained in the subsoil and rivers of Spain, while the international section will bring before owners of mines and waterfalls the most improved machinery and tools at present in use in other countries. The government has consented to allow free entry of all exhibits and the railway companies have granted special freight rates. A congress of producers will be held during the six months or more the exhibition remains open. As a special concession, American exhibits will be admitted as late as October, November and December, provided that the requisite floor space is applied for and secured before September 25.

Possibilities for American Contractors.

Consul General Guenther of Frankfort, Germany, writes of the following open contracts. The minister for the colonies at The Hague, Holland, will receive bids to furnish 1,371 tons of cast-iron water-pipe for use for the water mains of Djoewana and Ambarawa, Dutch East Indies. The city of Buenos Ayres, Argentina, will require many new cars owing to the extension of its tramway lines. The following new railway lines are to be constructed in Argentina: a connecting line between the central Norte and Buenos Ayres and Rosairo railroads. A narrow gauge road from Rosairo to Bahia Blanca and a line to start from San Rafael to Toay. The street railway company (Schaffhausen Schleitheim) at Schaffhausen, Switzerland, will receive proposals for furnishing materials required for an electric tramway line.

A DAY LOAD AS A FACTOR IN CENTRAL STATION EARNING CAPACITY.[1]

BY LEHMAN B. HOIT.

The object of this paper is to consider briefly some of the essential features of electric power transmission from a central station point of view, and to give a partial appreciation of the comparative relation of the items of costs, returns and load-factor which this industry bears to the isolated systems of electric power transmission for manufacturing purposes.

As to the treatment of this topic, it is intended to be suggestive only, it would seem at the beginning that it would be well to get together a few of the facts in relation to the progress made in the generation and transmission of electric energy, and to say something of its future development in fields where the items of cost or the actual power realized seems to have so much to do with the question.

Electricity, which a few years ago was considered something wholly immaterial, so far as general use for commercial power transmission was concerned, has now acquired a sufficiently objective existence to admit of being manufactured and sold as raw material, the same as lumber, leather or pig iron. The immense service which it has rendered in the field of illumination and its present continued necessity as a prime factor in the encouragement and development of small industries, seems to predict its ultimate supremacy over the other systems of power transmission now in vogue. Electrical transmission from a central station has enjoyed the benefits of careful and efficient design, and in minor ways has proved a useful servant not only for lighting, but for many lines of work requiring small and easily controlled power. This fact should be sufficient to stimulate a greater impetus in the direction of developing the day load-factor.

While it is true that electricity has worked and is still working wonders in widening its application to the valuable service of illumination, its relative economic value for the transmission of power to the large manufacturing industries is one of the mooted questions of the day, and one whose ultimate settlement may depend largely upon the aggressiveness and ability of the electric light companies to enter the field against their formidable competitors.

Primarily the organization and development of central lighting plants was, as applied to private and municipal lighting, simply a means to the end. Upon entering this new field it had to contest every inch in order to displace the ordinary illuminants. There were few guides or aids to assist them, and the early companies found themselves in a field outside of all previous experiences, and in blissful ignorance of the many wastes incident to the manufactory and distribution of electric energy. They had no disinterested all around friends to look after their interests, nor interested ones either, and the companies were obliged to be content with the returns from the sale of the product paying expenses and taking what was left.

The law of natural selection, however, by the process of the "survival of the fittest," exerted its influence over the realm of the struggling companies and the development of this new industry was assured. Only after untold time, thought and money had been spent in the accomplishment of successive small gains and efficiency in operation, however, has the subject of power transmission economies been accorded that degree of attention and careful consideration which its importance has long merited. In proportion to the greater advantages derived from the greater station economies, the desire of gain in output became a new incentive to activity. The companies learned, however, by experience, that while they were able to dispose of a certain amount of product for the purpose of illumination, at a fair profit, a larger output required not only extensive improvements in the matter of machinery for production, but also in distribution. The machinery and line construction which thus cheapened and increased the output was costly and entailed a like burden of interest, depreciation and cost of maintenance, whether it was at work or idle.

Recognizing this fact, the companies desired naturally to convert the outlay for machinery and equipment into income by utilizing it to the greatest extent possible and over a longer period than was required for the service for which the current was consumed. Many of the companies found it expedient to generate elec-

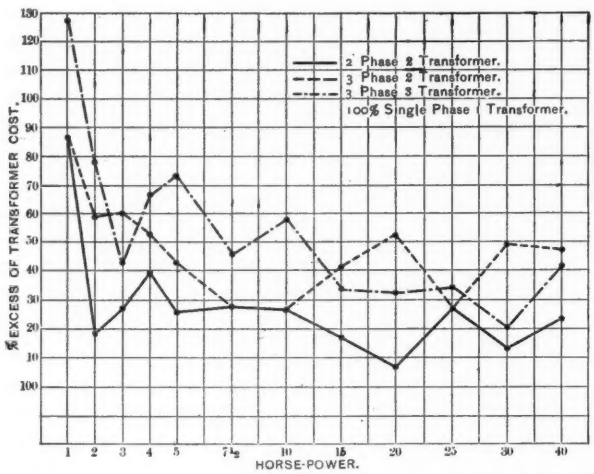


FIG. 1.—EXCESS IN FIRST COST OF TRANSFORMERS TO OPERATE MULTIPHASE MOTORS.

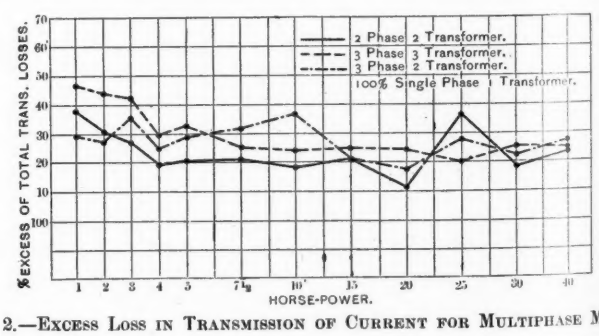

2 Phase 2 Transformer.
3 Phase 3 Transformer.
3 Phase 2 Transformer.
100% Single Phase 1 Transformer.
% EXCESS OF TOTAL TRANS. LOSSES.
HORSE-POWER.

FIG. 2.—EXCESS LOSS IN TRANSMISSION OF CURRENT FOR MULTIPHASE MOTORS.

tricity during the full twenty-four-hour day, and although the day load-factor was disproportionate to the average night load-factor, the returns were satisfactory and profitable. But there was a limit to its usefulness, except within certain bounds, on account of losses incident to transmission, and the companies, notwithstanding the high-station efficiencies they had secured, were not able to compete with even the most inefficient units installed by

[1] Paper presented before the Ohio Electric Light Association, August 16, 1904.

manufacturing industries, public institutions and others.

The difficulties attendant upon the transmission of electricity from a point where it can be cheaply generated, and its safe and effective subdivision and distribution as a motive force, have been overcome in the choice of alternating-current apparatus. With this form of electric energy distributed from a central station, it is not improbable to prophesy that the necessity of multiplying expensive and inefficient machinery for the local generation and application of electricity for industrial purposes will be ultimately avoided. Still, there is much to be done in the field of power transmission to enable the producer to deliver the energy at prices sufficiently low to be attractive and sufficiently high to yield a fair interest on the investment.

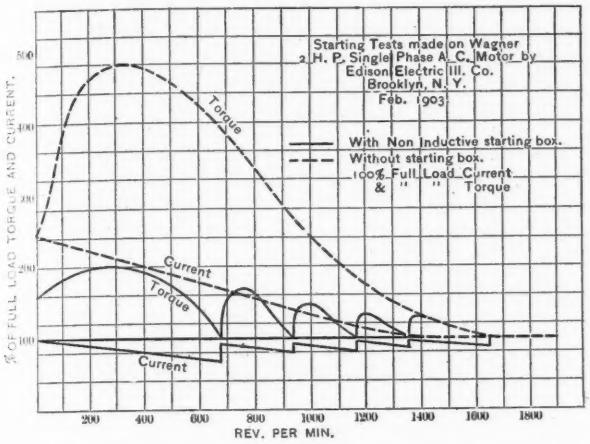

Starting Tests made on Wagner 2 H. P. Single Phase A. C. Motor by Edison Electric Ill. Co. Brooklyn, N. Y. Feb. 1903
With Non Inductive starting box.
Without starting box.
100% Full Load Current
&
Torque
Torque
Current
Torque
Current
% OF FULL LOAD TORQUE AND CURRENT.
REV. PER MIN.

Fig. 3.—Starting Tests on a Wagner Two-Horse-Power Motor.

We have abundance of information as to the cost of producing the raw material and the expenses incident to the transmission and conversion of electric energy, but when it is sought to apply this to the commercial side of the problem, the subject becomes complex. It is not only difficult, but in many instances impossible to draw accurate conclusions regarding the selling costs from data which have not been derived from the same line of work to which the application is made, and it would seem like asking a suspension of judgment upon the claims made by many manufacturers that the cost of production determines the selling price, until the subject has been fully presented.

Many schemes have been suggested for the purpose of increasing the day load-factor; some in the nature of combination with other industries; some covering the storage of electricity, and others the combination of railway and light service, but of the many interesting schemes which have been suggested, the successful one seems to rest in the gradual development of a day load-factor by interesting small manufacturers in the use of electric power. This field has been given the most careful consideration by station managers, and has led, in many instances, to the organization of efficient sales departments in order to secure the business.

In the distribution of direct current for power transmission the size or type of motor to be driven has little to do with the question of costs in furnishing a day load-current, but in the use of alternating current there were many points to consider in entering the field for a day power-load.

The majority of companies furnishing alternating current for power transmission realize that the profits or earning capacity of the station depend not only upon high station equipment and distribution, and low service maintenance charges, but also upon the losses in the way of transformer construction, before they are able to receive a profitable return for the secondary current.

The transformer equipment no less than the power plant proper entails a continuous expenditure for operation and maintenance, which forms a portion of the operating cost or fixed charges whose least reduction is a direct addition to net profits. It would seem, therefore, that the system of distribution and transmission which represents the least aggregate losses would be that which is best to use.

In discussing the costs relative to the secondary current where the current is used for power purposes and in the selection or recommendation of the type of alternating-current motor to be used on the company's circuits the accompanying curves will be of some assistance to the engineer and station manager.

As the use of the single-phase motor requires the simplest system of transmission and distribution we shall use the losses incurred in supplying the secondary current for this type as a basis for determining the losses incident to the use of polyphase apparatus.

Curve No. 1 shows the excess of the first cost for transformers to operate multiphase motors, as compared with single-phase. It will be observed that the excess of cost of transformers alone varies from an average of about twenty-five per cent for two-phase motors to an average of about fifty per cent for three-phase motors operated on two transformers.

It is apparent in considering curve No. 1 that the difference in cost between the use of single transformers for single-phase motor, and the use of two transformers for polyphase for a given purpose and capacity represents a loss to the company in the matter of interest and depreciation charge in exactly the same ratio as given above.

Curve No. 2 shows the excess loss in transmission of current for operating multiphase apparatus. In addition to the losses by the use of two transformers in connection with two or three-phase motors, it is necessary to increase the size of the transformer in order to take care of the excess energy load. Transformers so connected give a current overload of approximately fifteen per cent with copper losses of approximately thirty per cent in excess of full load copper loss. The following curve shows the excess losses over single-phase motors.

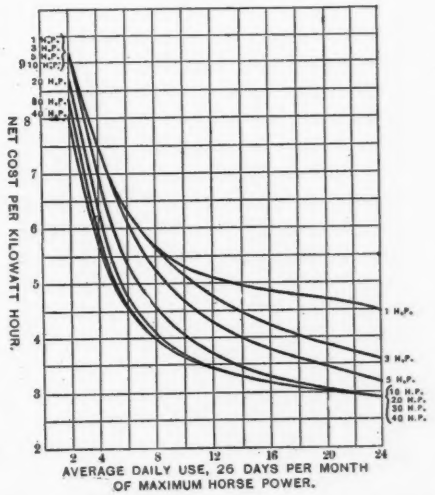


Fig. 4.—Rate System Used by the Chicago Edison Company.

For convenience the calculations in

sizes and losses as shown in Figs. 1 and 2 are tabulated as follows:

Transformers Required.					Total Transformer Losses.			
Horse-Power of Motor.	Single Phase. Kilowatts.	2-Phase 2-Trans. Kilowatts.	3-Phase 2-Trans. Kilowatts.	3-Phase 3-Trans. Kilowatts.	Single Phase.	2-Phase 2-Trans.	3-Phase 2 Trans.	3 Phase 3-Trans.
1	1-1	2- .6	2- .6	3- .6	57	78	74	83
2	1-2	2-1	2-1.5	3-1	88	114	111	126
3	1-3	2-1.5	2-2	3-1	112	142	151	171
4	1-4	2-2	2-2.5	3-1.5	147	176	182	190
5	1-5	2-2.5	2-3	3-2	167	202	211	222
7½	1-7.5	2-4	2-4	3-2.5	242	294	318	303
10	1-10	2-5	2-5	3-4	390	334	395	361
15	1-15	2-7.5	2-10	3-5	400	484	484	501
20	1-20	2-10	2-15	3-7.5	502	580	590	726
25	1-25	2-15	2-15	3-10	585	800	750	703
30	1-30	2-15	2-20	3-10	675	800	824	860
40	1-40	2-20	2-25	3-15	825	1004	1039	1032

It is obvious that the transformer losses by the use of polyphase apparatus are important factors in determining the value of a day load and the earning capacity of a plant.

Some of the strongest advocates of the single-phase motors are plants having multiphase generators only and the wave of approval is now far-reaching. Practically all of the large central stations generating two or three-phase current now use single-phase motors. It is the general opinion that eventually the central stations will advocate the single-phase motors for capacities up to and including forty horse-power in preference to multiphase, on account of the superior simplicity of the primary and secondary transmission. The following list of stations and their policy is suggestive.

Name of Company.	System of Distribution.	Size of Single-Phase Motors Installed.
Chicago Edison Co., Chicago, Ill.	Three-phase, 4 wires.	Single-phase exclusively up to and including 5 horse-power.
Columbus Edison Co., Columbus, Ohio.	Two-phase.	All sizes. Larger sizes with non-inductive starters.
United Electric Co., of New Jersey.	Two-phase.	All sizes. Larger sizes with non-inductive starters.
Cleveland Electric Illuminating Co.	Three-phase.	Three horse-power or less.
Brooklyn Edison Co., Brooklyn, N. Y.	Three-phase.	Five horse-power or smaller. Larger sizes depending upon location.
Missouri Edison Elec. Co., St. Louis.	Monocyclic and two-phase generators, single-phase distribution.	Single-phase motors only.
Washetenaw Electric Light and Power Co., Ann Arbor, Mich.	Three-phase generators, single-phase distribution.	All sizes.

Curve No. 3 shows the starting tests made by Brooklyn Edison Company on a two-horse-power Wagner single-phase motor. This diagram shows the results of the tests made to determine the effectiveness of non-induction starters. You will note that the full load was brought up to full speed without exceeding full-load current. Another strong point made is the greater ease of controlling the starting current of single-phase motors as compared with polyphase motors, owing to the necessity for controlling the current in two or three circuits instead of one. All starting devices for polyphase motors are of complicated character, if in the form of resistance, and when not in the form of resistance are ineffective.

We have considered the several particulars in which the commercial aspect regarding the cost has a strong bearing upon the development of central stations, but it is probably safe to say that much time will be required to determine all matters which concern the cost of power and its relative value to the commercial field.

As soon as the rate for power can be lowered a greater stimulus will be given to the development of this line of industry. This question has been given the most careful consideration by nearly all central station managers, and has led to the design of what is known as a maximum demand meter, which records not only the total amount of current used during the month, but the maximum amount used at any one time. It is obviously only fair that the charge for current should be based partly on the capacity which the consumer requires, as well as the amount of current he actually uses, and the rates are so adjusted that for the total amount of current taken, that the price is much lower when the maximum demand is low than when it is high.

Many of the companies have devised a rate charge best suited for the class of customers they supply. The Chicago Edison Company employs a rate system, the discounts of which gives the rates as shown in the curve No. 4. For example, the rate for a five-horse-power motor running four hours a day at full load would be approximately seven and one-half cents per kilowatt-hour. For the same motor running ten hours a day, the rate will be approximately four and three-quarters cents per kilowatt-hour.

A very important consideration in securing satisfactory services from either single or multiphase motor is the maintenance of proper pressure under all conditions. The low capacity of an alternating-current motor drops off very rapidly as the pressure falls below the normal, and it is therefore objectionable to run motors on pressures below that for which the motor was designed. This fact makes transformer regulation a very important consideration to good alternating-current motor service.

The Panama Prospect Not Satisfactory to Our English Contemporary.

"Mr. G. E. Walsh, in the Electrical Review, of New York, prophesies that there will be some splendid contracts for electrical manufacturing firms in connection with the completion of the Panama canal. He assumes—and we are afraid he is correct in his assumption—that only American firms will have a chance to get this work. In the earlier history of the enterprise, when French engineers were responsible for the work which ended so disastrously, English firms had a good share of the contracts, and we think that even now they should be allowed to compete. Of course, if protective duties in favor of American firms are enforced, it will be a waste of time to attempt to secure contracts for this country. Mr. Walsh adds that electricity will play a large part in the excavation and equipment of the canal, and that there will be hardly a machine, repair shop, or operating plant which will not have electric power in some portion of it. He further states that within six months the designs and specifications for the first part of the machinery will be completed, and that the delivery of certain machinery may even be required this year or in the early part of next. After considering the local conditions, he is inclined to favor oil as the cheapest fuel, owing to the high cost of transporting coal or wood to the sites where power will be required. The article concludes with a prediction that the American plant used in the construction of this canal will do much to secure for the United States the electrical orders from South and Central America which heretofore have come to England or Germany. May he prove a false prophet."—*London Electrical Engineer.*

Electrical Notes from Europe.

By Our Special Correspondent.

ONE of the large railroad lines of Paris has recently adopted electric locomotives for a considerable length of track in the suburbs. The greater part of the tracks of the Orleans railroad which lie inside the city limits has been equipped with electric locomotives for several years past, and the new system, which was installed by the Thomson-Houston Company, proved quite successful. It was then proposed to extend the electric system to the suburbs and to equip an electric line which is to run eventually as far as Bretigny, a distance of twenty miles. At present the first section of the electric line has been completed, and trains are now running. The trains are made up of a high power electric locomotive coupled to the railroad cars. The locomotives are of the same type as is used on the line passing along the Seine; a description of this has been previously given. The generating station at Ivry is to be considerably enlarged to provide for the new road, and a number of units will be added. The line is to be supplied by two new substations. One of the main objects in running the electric line, which will double the number of tracks between Paris and Bretigny, is to take the suburban traffic off the main tracks and leave the latter free for the rapid express trains. The new system affords a separate set of tracks for the rapid and slow trains. Exclusive of the rolling stock, the total cost of the twenty-mile line will reach $5,400,000.

A project is on foot for using electric hauling upon some of the canals in Russia, especially on the canals of the Ladoga region, which connect the numerous lakes in the region to the northeast of St. Petersburg. This system represents about forty-two per cent of all the canals in the country, and has a considerable traffic. One of the projects which has been proposed is to furnish all the current for the hauling motors from two main generating stations. The boiler furnaces would burn crude oil, which could be brought to the spot *via* the Volga river. According to the second project, the station would be operated by low-carbon gas engines, the gas to be supplied by generators which are heated with peat fuel. The latter is abundant throughout the region traversed by the canals. At first it was proposed to use hydraulic power for operating the plant, and the government had a project examined in which the falls of the Wolchow were to be used, but the course of that stream is so rapid and the supply is so irregular that such a plant could not be counted upon for a steady supply of current. The engineer, Rando, who examined it, therefore renounced this project in favor of steam, which will no doubt be used. The average speed of the tractors which are to draw the canal-boats will be from three to six feet per second.

M. Stosberg brings out some points relating to the deterioration of microphone contacts. When he examines the carbon contacts of a microphone which has been in use for a long time he finds that the contact is covered with a badly conducting powder, which has somewhat the appearance of ash. On this account the microphone transmitter works badly, the articulation is lost as well as the sharpness. It is evident that the carbons should be cleaned off from time to time, but this occasions some labor and expense. In order to overcome the difficulty he proposes to prevent the formation of the deposit at the contacts by suppressing the sparking, which he considers to be the cause of it. This is accomplished by putting a resistance in shunt upon the microphone. This resistance gives the maximum effect when it is made equal to three times the resistance of the microphone in repose. It is best to make it of nickel wire, 0.16 millimetre in diameter, which is wound in the form of a ring so that it can be lodged in the base of the microphone. The mean resistance of the microphones he used is about twenty ohms. Four metres of the nickel wire will make the parallel resistance equal to sixty ohms. In the central stations it is convenient to replace the resistance wire by a galvanometer which has the same resistance. This will enable the employés to observe the condition of the battery. An automatic device connects the galvanometer in the circuit when the microphone is used.

The first hydraulic plant to be installed in Madagascar is now in operation at Tendro. The station is located on the Ikopa river, and the rapids of the stream afford a fall of 100 feet. The total output of the fall is 7,000 horse-power, but less than one hundred are as yet employed. The first turbine in the station drives two dynamos of 650 volts. Current is used mainly for operating motors in the Suberbri rice plant, which has a large factory a few miles from the station. The maximum loss in the transmission line is eight per cent. The present plant lies in the centre of a large rice-producing district, and according to reports the total yield is 25,000 or 30,000 tons.

Electricity is extensively used for agricultural purposes in the department of Aisne, France. The current from a large station is sent over a high-tension line to sixteen substations which are located at different points in a fertile region. As to the motor-driven apparatus which is now using the current, it may be mentioned that there are nearly forty electric threshers and twenty-five root-cutters, besides different apparatus for dairy use, pumps, flour mills, etc. Current is also used for lighting and for electric heaters. The larger proprietors own the motors which they use on the farms, while the smaller ones club together by two or four and use a common motor, which is mounted on a carriage, and can be taken from one place to another. These motors are run at a specially reduced price and even the smallest farm can use them with great economy. At present nearly forty of the farms are using electricity exclusively as a motive power. The central station, which has been equipped by the Société Alsacienne, will soon be increased by adding a 150-horse-power alternator which runs at 5,200 volts and fifty cycles.

Some interesting researches have been recently made by E. Goldstein, a German scientist, in regard to the ozonizing power of ultra-violet rays. It is known that quartz will let these rays pass through it easily. The experimenter takes advantage of this fact to produce the rays by an electric discharge between two platinum electrodes which are fixed at the ends of a quartz vacuum tube. By the action of the ultra-violet rays which pass through the tube, the surrounding air becomes ozonized, and the ozone is observed to form just around the tube. This effect is increased as the light becomes stronger. Liquid oxygen is not thus ozonized, but if the gas is passed through a discharge tube and at the same time cooled to 100°, it is transformed into ozone. A tube is used which has a pressure lower than the vapor tension of the latter body. When the discharges are made to pass, the ozone

is seen to form in a bluish layer on the walls of the tube. By sending fresh supplies of oxygen into the tube the ozone can be produced continuously. As the oxygen has a higher vapor tension, it does not deposit like the ozone. The liquid ozone which is thus produced is not explosible by the discharge at this low temperature.

The Dolter system of surface contacts is now running very successfully on a portion of one of the Paris traction lines which runs through the Bois de Boulogne. As the trolley could not be used on this part of the line it was decided to use the present system. When the cars reach the end of the Bois they are run to the suburbs across the Seine by the trolley system. The Dolter system bears some general resemblance to the Diatto surface contact which was described recently. It consists of a series of surface plates which send current into a rail carried under the car. Each plate is mounted in the top of a contact-making device which lies beneath the paving. The rail on the car is magnetized by a set of coils, and is formed of two parallel iron bars. The surface contact has two magnetic poles corresponding to the double bar. When the rail passes over the plate the magnetic action causes a lever to operate within the apparatus. The lever carries a carbon contact which comes against a second carbon piece which is fixed to one side. Current is thus established, and it passes into the car through the rail. When the rail leaves the contact the lever drops, separating the carbons and breaking the circuit for that plate. The rail on the car is twenty feet long. The distance between the ground plates is fifteen feet. The cars make a speed of seven metres per second, while the time required for the levers to break the current is only one-sixteenths of a second. Thus the plate is always dead before the car leaves it. A safety device is also provided to make this quite certain. If the lever fails to drop, a fuse blows inside the apparatus and cuts off the current.

The Ikervar hydraulic plant is the first of any size to be established in Hungary. It is situated on a fall in the river Raba, and furnishes a supply of current which is transmitted throughout a populous region. The current is utilized for different industries and it is to be remarked that it is also extensively applied in agriculture. The first part of the plant was installed in 1896 and includes three turbine dynamos of 600 horse-power. It supplied a circuit forty miles long at 6,000 volts and sixty-five amperes maximum current. In 1901 the station was further extended and two new turbine dynamos of 600 horse-power were installed. These dynamos supplied a second and independent circuit which already reaches nearly 100 miles in total length. It uses a maximum of 10,000 volts and a current of forty amperes. The first-mentioned circuit of 6,000 volts passes by the town of Szombathely, an important locality. Here are several substations, the largest of which has three rotary groups, each composed of high-tension motors placed in the line circuit coupled to two shunt-wound dynamos. The second long-distance circuit runs through the town of Sapron and has also several substations, one of which gives current for the local tramway. Most of the electrical outfit has been supplied by the Compagnie L'Industrie Electrique, of Geneva, on the Thury system. It is to be remarked that motors are extensively used throughout the region for agricultural purposes.

Among the systems of electric ignition for gasoline motors the internal spark-break placed inside the cylinder is now proving a favorite, and many of the leading automobiles have adopted it. Among the cars which used it in the Gordon Bennet cup race may be mentioned the French Mors car and the German Mercedes. Instead of the usual spark-plug, a mechanical break is made in the cylinder head. This is carried out by using a contact piece which is fixed inside the cylinder. A movable contact, mounted on a lever, can strike against it and so make and break the current from an induction coil to form the igniting spark for the gas. The device is mounted on a circular disc which is bolted against the side of the cylinder. The lever shaft of the turning contact passes to the outside by a tight joint and carries a lever or trip. The trip is worked by a vertical rod which moves up and down, and its end raises or lowers the trip and thus operates the spark-break. The rod is worked by a cam which is placed on a secondary horizontal shaft running parallel to the crank shaft and driven from it by gearing. For a four-cylinder motor there are four cams and four spark-breaks.

An electric chronometer system for automobiles has been lately brought out by the Mors Company, of Paris. It is an improvement over the use of the stop-watch, and much more accurate results can be obtained. At the starting point a wire is stretched across the track. When the car starts, it passes over the wire, thus drawing it down, and the wire pulls upon an electric contact device. To register the start and stop an electric apparatus is placed at the start and finish, and the two are connected by a wire. At the starting point is the contact-making device and also a telephone outfit for communicating between the two points. At the other end is the registering device, which forms the essential part of the apparatus. A Morse register unrolls a band of paper by clock-work. As it passes along over a support, it is punctured with holes by a needle attached to a core which works in a solenoid. Impulses are sent in the solenoid every one-fifth second by a chronometer and contact. Thus the paper comes out with series of dots spaced five millimetres apart and representing one-fifth second. The band can be punctured by a second needle to register the start and finish. This is carried out by a solenoid which receives a current impulse when the automobile passes over the line. In this way the exact number of spaces and fractions covered during the traject can be read, and the time is thus registered accurately within 1-100ths of a second, or even less.

Among the new Swiss electric railroads may be mentioned the Fribourg-Morat-Anet line. It has a standard gauge track. The trains are made up of large motor cars and trailers, together with freight cars. The motor cars or locomotives are of the double-platform type, with a motorman's cab at each end and the rest of the space for the passengers. Two trolleys are carried on the roof for use in some places, but in general the third rail is used on the line. The motor cars carry two Oerlikon 150-horse-power motors. The voltage is 750, and the motors make 400 to 450 revolutions per minute. They are of octagonal shape and weigh about three tons each. Each platform carries a controller provided with a magnetic blow-out. The grades on the line between Morat and Anet reach twenty to thirty per cent on a length of twenty miles. The trains make a speed of fifteen miles an hour on the heavy grades, and twenty-five miles on the level. On the down grades they reach thirty miles an hour. The line receives current from two substations which are placed near it at Pensier and Anet. The primary line brings three-phase current from a large station in the vicinity.

Paris, August 27.

C. L. DURAND.

TURBO-GENERATORS EXHIBITED AT THE WORLD'S FAIR.

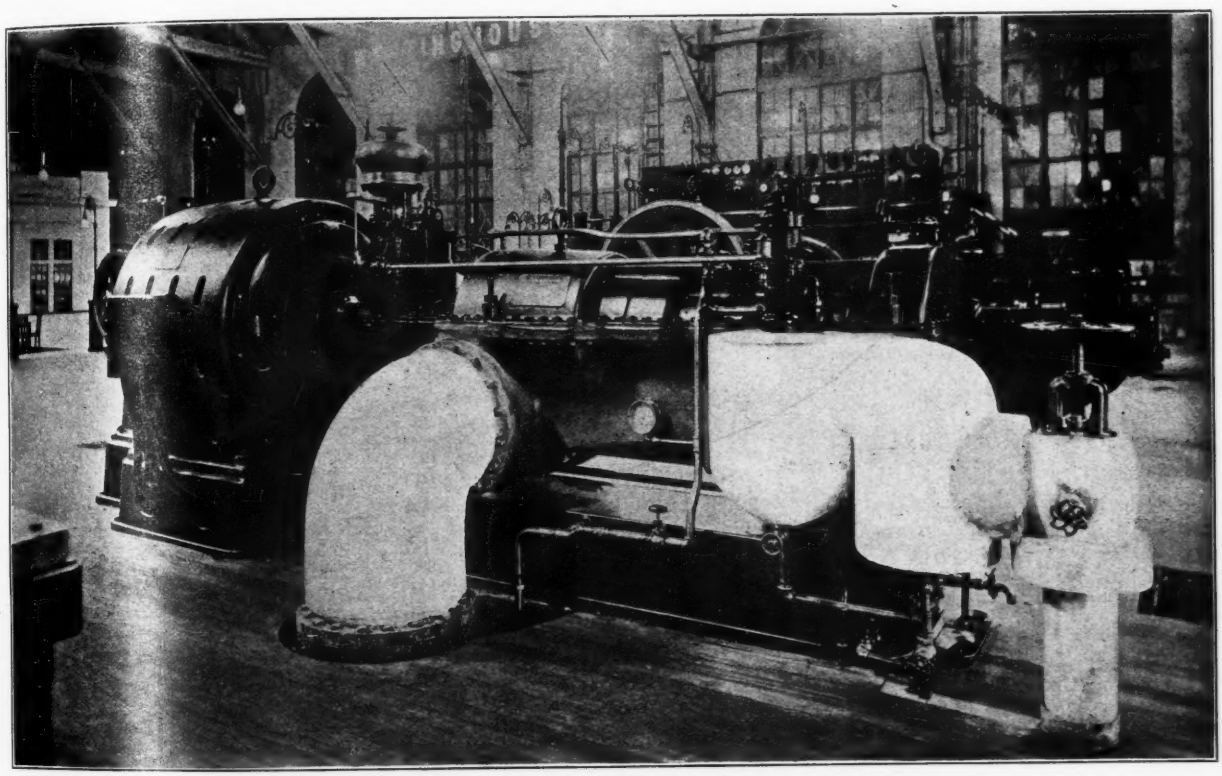
[*By Our Special Correspondent.*]

The turbine has entered the steam engineering field to stay, and to-day no large electric power station is being designed without careful consideration being given to the merits of this type of prime mover. Until the last five years the development of the turbine has been altogether European; then three or four large American companies began experiments based upon European patents and practice. Nearly all the steam engine and many of the generator manufacturers are carrying on experimental work to be prepared for the radical changes which may come in the immediate future. A number of the largest electric power stations now being constructed are installing turbo-generators of American manufacture. Perhaps the most notable examples are the electric railway stations around New York. Wherever land is valuable the turbine offers a marked saving in space; in fact, in some tions now designed with vertical turbo-generators and boilers, the area of the entire station does not exceed the area now occupied by the boiler room of stations with the same capacity. When a 3,000-horse-power unit, including turbine, generator and condenser, covers an area of but ten and one-half feet by eleven, the space occupied by the prime mover has been reduced to the minimum.

The Westinghouse, General Electric and De Laval companies have given more consideration to the development of the steam turbine than any other American manufacturers, and all three are represented at the Louisiana Purchase Exposition.

When the Westinghouse-Parsons steam turbine in the Westinghouse exhibit, Machinery Hall, was started on its long run early in June, a steam turbine was seen in operation at a world's fair for the first time. This unit, of 600-horse-power capacity, is the smallest at present built by the Westinghouse Machine Company, and was selected for exhibit because of its extended use for power stations of moderate size. Many larger equipments are now in operation in various parts of the world, and a number of machines now nearing completion at the East Pittsburg works are of 7,500-horse-power capacity. The practical successes and economical operation of turbines already in service have been so completely demonstrated in recent years that the turbo-generator is no longer regarded as an experiment by well-informed engineers.

Since the Westinghouse steam turbine was first put upon the market as a prime mover in 1898, the two principal advantages of the turbine over the reciprocating engine, simplicity of construction and economy of space, have become matters of common recognition. The turbine's low steam consumption is another important feature. Piston engines are tested under conditions which seldom hold in practice, and results are stated in indicated horse-power. The Westinghouse-Parsons steam turbines are tested under working conditions, and their rating is given in actual horse-power measured by brake or electrical output. The increasing loss in the economical operation of piston engines, frequency reaching ten per cent to fifteen per cent as they age and wear, gave an opening for a new prime mover which should retain its original steam economy after years of service, and such an achievement is claimed for the Westinghouse-Parsons turbines, some of the original machines which have been in use for eleven years having lost but one-quarter of a cent a kilowatt-year for repairs. The construction of the steam turbine, with no rubbing parts excepting the bearings, results of course in a high mechanical efficiency because of small friction losses. The fact is also generally appreciated in the technical world by this time, that the turbine needs no cylinder oil for

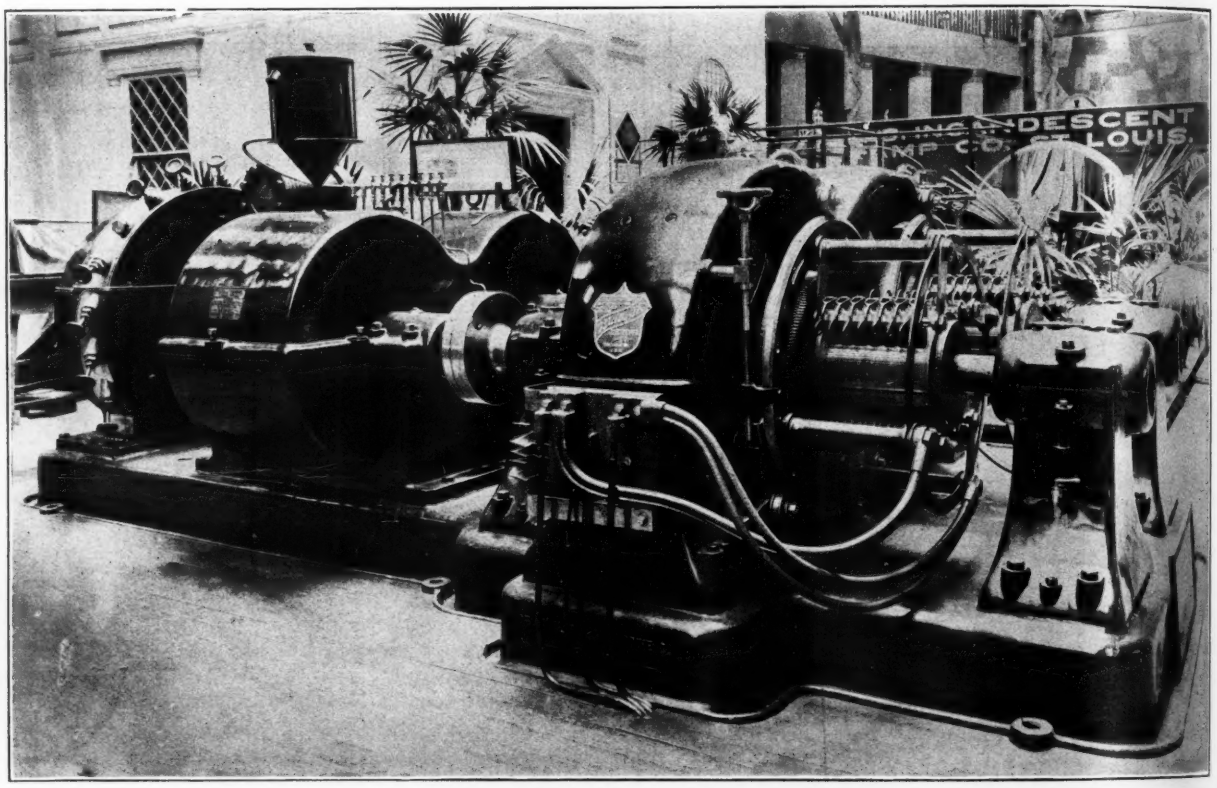


WESTINGHOUSE STEAM TURBINE, WORLD'S FAIR, ST. LOUIS, MO.

lubrication, so that the condensed steam may again be fed into the boilers.

The Westinghouse Machine Company has already furnished, or has under construction, 175,000 horse-power in the Parsons steam turbine in the past few years, and the construction of the machine is somewhat familiar to many engineers. The fundamental principle of the steam turbine is conversion of power from the kinetic energy of the steam jets impinging upon the vanes of a rotating bucket wheel. The Westinghouse type combines the action of an impulse turbine with that of a reaction turbine and employs the principle of multiple expansion for the reduction of steam velocities instead of a single expansion as in the impulse turbine.

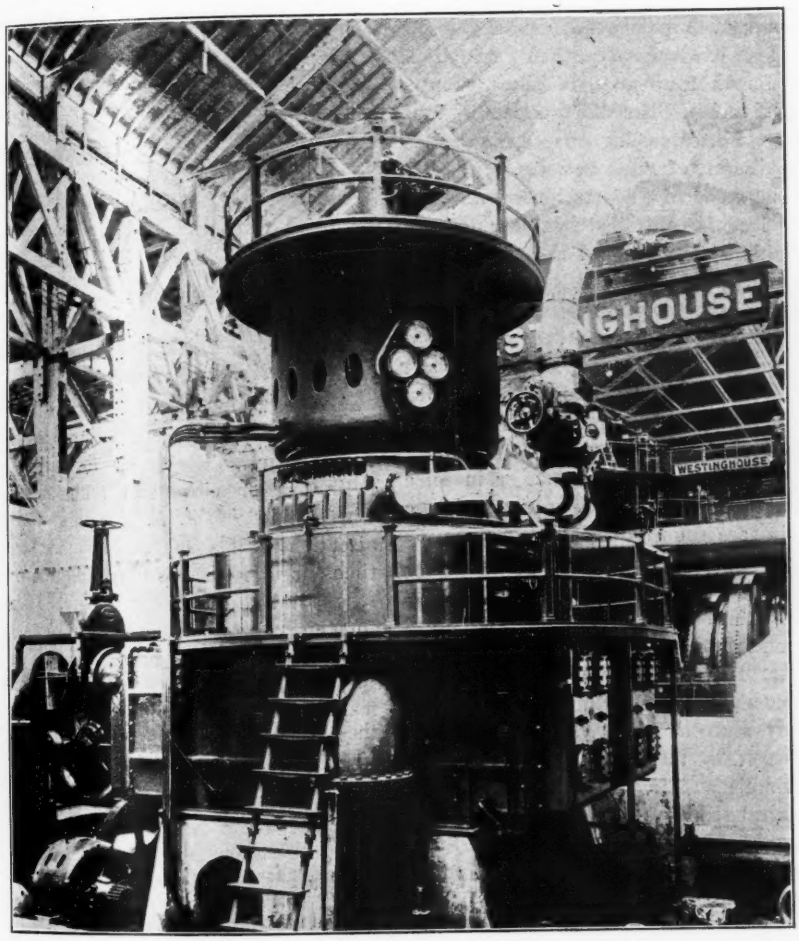
There are three essential parts to the turbine, the rotor, the stator and the balancing pistons. The rotor consists of a cylinder of three or more drums of increasing diameter, upon the periphery of each of which are mounted numerous rings of radial vanes. Direct-connected to the rotor shaft is the rotating field of the generator. The special construction of the rotating field of the Westinghouse turbo-generator can be seen in the Westinghouse exhibit in the Palace of Electricity, where a 400-kilowatt generator of the same size and type as that in operation in Machinery Hall is set up for inspection. The stator comprises a split casing of interior proportions conforming to those of the rotating cylinder. The interior walls of the casing are studded with rows of stationary radial blades corresponding to those on the moving cylinder, but assembled with a reverse pitch. Upon the adjacent surfaces of both the stator, or cylinder, and of the rotor, or spindle, are rings of blades between which the steam passes. Steam enters the working part through a ring of stationary guide blades which give it direction. Expanding beyond these blades the steam impinges upon a ring of moving blades which receive first the impact and then a reaction due to the difference in pressure on the two sides of the ring blades, this series of action being repeated throughout the cylinder, the pressure of the steam alternately decreasing and increasing with the passage through the alternating rings of blades, and gradually lowering that of the vacuum. In this form of turbine the area for the expansion of steam is secured by gradually increasing the annular volume between rotor and stator, which may be regarded as single annular nozzles. Blades of increasing length are employed in the first drum until a mechanical limit is reached, when the diameter is abruptly increased and a second progression begun with shorter blades, these again lengthening to the end of the second drum. The rotating-balance pistons are equal in number to the number of drums, and each piston is of such diameter that the axial thrust resulting from the impact of the steam upon the blades of any drum is exactly balanced by corresponding pressure against the pistons. These pressures are at all times equalized by means of the ports and the pipes, so that the balancing of the rotating element is entirely independent of the absolute or relative pressures in the various stages. The balance pistons revolve within the casing with a close fit, but without mechanical friction. Leakage of steam past the piston is prevented by deep grooves in the periphery, which interposes so devious a path for the steam as to render loss from this source quite inappreciable. The speed is regulated by a centrifugal governor somewhat like that in the usual steam engine, steam being admitted according to the work to be done. The unit exhibited in Machinery Hall works at 150 pounds steam pressure, and is provided with a surface condenser. The bearings, because of the high speed, are provided with forced lubrication under the pressure of a small pump driven by the turbine itself. The generator is three-phase, 440 volts, 7,200 alternations, and revolves 3,600 times a min-



THE DE LAVAL TURBO-GENERATOR OUTFIT, WORLD'S FAIR, ST. LOUIS, MO.

ute, or at a peripheral speed of about 7,000 miles a day. This unit in operation furnishes all of the alternating current for the Westinghouse exhibits in the Palace of Machinery, Electricity and Transportation. It is planned to run the machine without a stop during the period of the exposition.

The De Laval is perhaps the oldest and best-known type of steam turbine in this country. Its earlier applications were not in the electrical field, but now special generators have been designed for connection to this form of turbine and it is being installed in central stations although not built in such large units as the other types described. A De Laval turbo-generator built for street railway service is on exhibit in the space of the Bullock Electric Manufacturing Company, section 15, Electricity Building. It is a standard 300-horse-power machine, driving through gears a double 200-kilowatt, 550-volt, direct-current generator. The generator is duplex in order to equalize the stresses in the turbine gear case. Each shaft carries an armature giving 25 to 275 volts and these are connected in series. Each frame has four poles and is of standard form, but the generator as a whole was designed and built by the Bullock company especially for the De Laval Steam Turbine Company. This turbine like others of the De Laval type may be operated either condensing or non-condensing by simply using the nozzles so marked, no other changes being necessary. The speed of the wheel which is thirty inches in diameter is about 10,000 revolutions per minute, but the actual working speed of the reducing gear shafts to which the generators are coupled is 900 revolutions per minute. The cardinal principle of the De Laval system is to expand the steam through nozzles so as to obtain a maximum velocity and to utilize this velocity by impinging the steam against buckets arranged on the periphery of a wheel. The ideal speed of this wheel is one-half the velocity of the steam which gives a very high rate of rotation. The velocity of the turbine wheel and shaft, in most cases too great for practical utilization direct, is considerably reduced by means of a pair of spiral gears, usually made ten to one, and these are enclosed in a gear case. The pinion which is made solid with the flexible shaft engages with either one or two gear wheels. The gear is forced on a heavy shaft which is connected through couplings to the armature of the generator.



Curtis Turbine Exhibited by General Electric Company, World's Fair, St. Louis, Mo.

The turbine wheel is mounted upon a slender flexible shaft and in such position relative to the wheel case as to revolve entirely free. The wheel case and the wheel-case cover are so shaped as to form safety bearings around the hub of the wheel for the purpose of catching and checking its speed in case of an accident to the shaft. The steam after passing through the governor valve enters the steam chamber where it is distributed to the various nozzles. These, according to the size of machine, range in number from one to fifteen. They are generally fitted with shutting-off valves, by which one or more nozzles can be cut out when the turbine is not loaded to its full capacity. This allows steam of boiler pressure to be almost always used, and adds to the economy on light loads. After passing through the nozzles, the steam is completely expanded, and in blowing through the buckets its kinetic energy is transferred to the turbine wheel. After performing its work the steam passes into a chamber and out through the exhaust opening. The turbine shaft is made very slender, which gives it a certain amount of flexibility and allows the wheel, when the so-called critical speed is reached, to revolve around its true centre of gravity. This critical speed, dependent upon the flexibility of the shaft, occurs well below the normal speed of the turbine and marks the disappearance of all vibrations. On the high-speed shaft and pinion a simple system of gravity oil feed is used, a tank for oil storage being placed in a convenient location either above the turbine or at a distance away on the wall of the engine room. All of the low-speed shafts are lubricated by the usual ring-oiling device. A very compact and sensitive centrifugal governor keeps the speed within a two per cent variation between no load and full load by means of a double ported balance throttling governor valve which controls the steady flow of steam into the chamber from which the nozzles receive their steam.

An excellent example of the vertical type of turbine is exhibited in the Machinery Building by the General Electric Company. It consists of a 3,000-horse-power Curtis turbine, direct-connected to an alternating-current generator produc-

ing 6,600 volts at twenty cycles, with a speed of 750 revolutions per minute. This is the first Curtis turbine to be built with the condenser in the base and with this arrangement the unit occupies a floor space of ten feet seven inches by eleven feet one inch, and twenty-two feet four inches above the foundation. The vertical form is favored by this company because it eliminates two difficulties encountered in the horizontal type; rapid deterioration of bearings due to excessive vibration, and friction due to expansion of parts of the turbine caused by variations of steam temperature. This change to the vertical design removes the difficulty due to vibration and also the difficulties due to variation in temperature at various points in the machine. As each part of the turbine is practically cylindrical, with uniform thickness of material, a gradual change of temperature takes place from the point of inlet of the steam to the exhaust outlet. The expansion which takes place may increase the diameter without detrimental effect, and the only variations due to expansion which require consideration are those due to expansion of the shaft and that is relatively small.

The step bearing at the base of the vertical shafts supports the weights of the revolving parts and maintains the revolving and stationary elements in exact relation. It consists of two cylindrical cast-iron plates bearing upon each other and with a central recess to receive the lubricating fluid, which is forced in by pumps with a pressure sufficient to sustain the weight of the revolving part. It is apparent that the entire weight of the machine is thus carried on a film of fluid and that there is no appreciable friction. When the flow of liquid is interrupted the bearing is slowly worn away, but experience has shown that interruptions in the flow seldom cause any deterioration which prevents the continuance of the machine in service after the flow is reestablished. The tendency of the bearing in such cases is to wear itself to a new surface so that it operates normally. In consequence of the exact relation maintained between the revolving and stationary elements by the step bearings, it is possible to operate the turbines with very small clearances between the moving and stationary buckets.

The design of this turbine permits the use of moderate speeds. It is divided into four stages, each of which contains revolving buckets supplied with steam from a set of expansion nozzles. The work is divided between the several stages, consequently the nozzle velocity in each stage is reduced, thereby rendering the nozzle action more efficient and perfect than when a higher initial velocity is imparted. Under this arrangement the energy of the moving steam is effectively given up to the revolving part. The division of pressure between the stages is so arranged as to utilize the largest possible proportion of the energy of expansion. Ordinary operation thus far has been with 175 pounds of steam and the vacuum of twenty-seven and one-half inches. Through the first stage the pressure is reduced to sixty-seven pounds, at the second to twenty-three pounds, at the third to atmosphere, and at the end of the fourth to vacuum of about twenty-seven inches. In the condenser four square feet of cooling surface is provided per kilowatt of rated capacity.

The speed of these turbines with variable load is controlled by the automatic opening and closing of the original admission nozzle sections, the number of nozzle sections corresponding to the load always being kept in flow. A centrifugal governor attached to the top of the shaft imparts motion to levers which in turn work the valve mechanism. There are a number of valves, each communicating with a single nozzle section, or in some cases two or more nozzle sections. These valves are connected to long pistons, by which the valve can be opened or closed by steam. The motion of each of these pistons is controlled by a small pilot valve which is worked by the governor mechanism. The movement of the governor mechanism moves the pilot valves successively and the main valves are opened or closed by the steam. The mechanism is simple and imposes a very light mechanical strain upon the centrifugal governor. By suitable adjustment, almost any degree of accuracy in speed control is obtainable.

The operation of this type of turbo-generator is so perfect that the casual visitor at the General Electric exhibit has to have his attention called to the fact that the machine is running. When it is considered that this is accomplished without the use of a drop of lubricating oil the performance is worthy of note. This turbo-generating unit is equipped with all of the most modern appliances, both steam and electrical, and represents a typical modern central station outfit. The turbine and auxiliaries are mounted on concrete foundations, all of which are located in a pit forty-four feet long by twenty-five feet wide and about five feet deep. These auxiliaries include a centrifugal Worthington circulating pump, direct driven by a 125-horse-power induction motor, a Worthington dry vacuum reciprocating pump belted to a fifty-horse-power induction motor, a centrifugal hot well pump, direct-connected to a seven and one-half-horse-power induction motor and a steam-driven oil pump. The induction motors used for operating these auxiliaries are run on 440-volt, twenty-five-cycle current. The exciter used with this outfit consists of a Curtis steam turbine, direct-connected to a twenty-five-kilowatt generator. This unit is of the horizontal type and operates at 3,600 revolutions per minute. The generator supplies current for the cascade pump motors which require 1,600 kilowatts from 11 to 12 A. M. and from 2 to 3 P. M. From 5 to 7 P. M. the load has been a variable one anywhere from 1,100 to 2,400 kilowatts used in operating rotary converters in the St. Louis Transit Company's substation supplying current to the cars running to the fair grounds. The remarkably smooth operation of these rotaries when supplied from the turbo-alternator unit has been commented upon by officers of the Transit company; in fact, the operation of this unit since steam was first applied to it has been very satisfactory.

P. E. F.

St. Louis, September 1.

Regulating Marine Clocks by Means of Wireless Telegraphy.

At a recent meeting of the Paris Academy of Science, M. Bigourdan proposed the use of wireless telegraphy for time signaling within cities and their suburbs. This has led M. J. A. Normand to call attention to his suggestion made some time ago that wireless telegraphy be used for regulating ship chronometers. Its use for this purpose would hardly be necessary for vessels making short voyages such as crossing the Atlantic, but for vessels making long trips an opportunity to check the chronometer during the voyage would be advantageous. This could easily be done since such vessels always pass close to land from which the signals could be sent. It would be sufficient if the ship came within 300 miles of the signaling station. It was suggested that these signals be made, say, four times a day at certain hours. At this time special signals could be sent at intervals of one second and in this way there would be no confusion between the time signals and any others.

A Telephone Problem.

A reader of the ELECTRICAL REVIEW presents the following problem in telephony, and would like to learn the experience of others who have faced similar conditions: There are four ground lines running parallel for a distance of four miles. There is considerable cross-talk on these lines which it is desirable to cut out at the least possible expense. What would be the effect of making one of the lines metallic, and how much good will a disturbance wire do?

PHOTOMETRIC EXPERIMENTS WITH SELENIUM.

BY FITZHUGH TOWNSEND.

The peculiar properties of selenium have only been generally known for about thirty years. In 1873 Willoughby Smith made use of selenium as an ohmic resistance in connection with experiments in telegraphy, and he accidentally discovered that the resistance of this peculiar metal was lessened by exposure to light. A valuable investigation of this property of selenium was carried out by Siemens in 1875, and his experiments

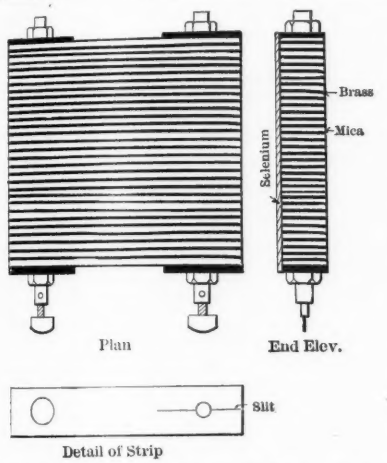


FIG. 1.—FRAME FOR SELENIUM RESISTANCE.

threw a great deal of light on the various forms which selenium assumes under different conditions. He also employed a sensitive resistance for the purpose of measuring candle-power. Most of the succeeding work since these experiments has been in the direction of practical applications rather than scientific investigation, and resistances sensitive to light have been repeatedly used in methods of transmitting sound and in light telegraphy. It will be found that there is very little literature on the subject which gives really accurate information with regard to the preparation and the properties of selenium.

This element, which was discovered in 1817 by Berzelius, can be obtained in various forms. After being melted and cooled quickly the selenium assumes a translucent vitreous formation, and upon being held up to the light it will be seen to have a rich dark red color. While in this condition it is a dielectric, and can be electrified by friction, like glass. If the molten selenium is, however, cooled slowly it will assume a gray crystalline formation, and it is then opaque to light and conducts electricity. This latter property, according to the electromagnetic theory of light, could not be present if the material were to remain translucent, and it is well known that all conducting metals are opaque to light. While in this condition the specific resistance of the element is extremely high, and in general too high to be put to any practical use. It is, however, sensitive to light. By heating for a number of hours either the vitreous form or the crystalline form just described the conductivity of the metal becomes greatly increased, and, if the temperature is reduced very slowly to atmospheric temperature, a high degree of sensitiveness to light is attained. It is in this conducting crystalline form that selenium is employed for signaling purposes. The vitreous form of the element melts at 210 degrees centigrade, but the crystalline forms have a considerably higher melting point.

Selenium, even when in metallic crystalline form, has an extremely high specific resistance, and it is necessary, therefore, to construct a rheostat made of it in such a way as to offer a great many paths for the current between one terminal and the other. One of the most usual methods is to cut two parallel threads in a refractory tube made of glass or lava, or some such material. A pair of parallel wires are then put on the tube so that they run spirally side by side along the threads. These two wires form the opposite electrodes. The tube is then made to spin in a lathe, and at the same

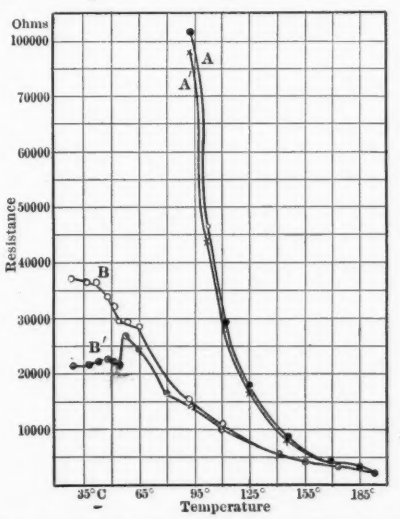


FIG. 3.—BAKING CURVE SHOWING EFFECT OF LIGHT AT VARIOUS TEMPERATURES DURING TREATMENT.

A —Curve in Dark—Heating.
A' " Light "
B " Dark—Cooling.
B' " Light "

time heated somewhat above 210 degrees centigrade. The vitreous selenium is then run along the tube, to which it clings in a thin sheet. This method of construction necessitates the use of a parabolic mirror, because otherwise the light rays would only fall on one-half of the sensitive material. In order to obviate this, resistances can be constructed so as to be plane instead of circular. Such a construction is illustrated in Fig. 1, which shows a series of metallic plates grouped together and separated from each other by mica. Alternate plates are connected together and to one of the binding posts.

Another way of accomplishing the same result is to wind two parallel wires close together along a broad piece of refractory material, such as slate.

In order to cut down the ohmic resist-

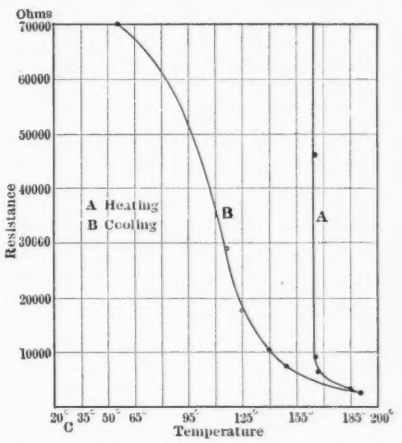


FIG. 2.—BAKING CURVE INITIAL RESISTANCE 746,000 OHMS, FINAL RESISTANCE 261,000 OHMS.

ance it is necessary to bring the adjacent wires or steps as near together as possible. This distance should be in any case considerably less than a millimetre. The selenium must be put on so as to form an extremely thin coating, because the light appears to act only on the surface of the metal, it being opaque; therefore, if any appreciable thickness is allowed, a great deal of current will be conducted from one electrode to the other through a part of the material which is not affected by the light, and it is desirable to cause the current to flow along the surface where the resistance is altered by the effect of the light rays.

It is obvious, since the two electrodes are composed of a series of wires or plates extremely close together, that the effect of any moisture deposited on the surface will be very noticeable, and that the surface must be kept dry, if the resistance is not to be affected by atmospheric conditions. In the latest developments by Professor Ruhmer, of Berlin, the selenium resistance is enclosed in an exhausted glass bulb, this having been found to give the best results.

Either brass, copper or silver may be used in the construction of a selenium resistance. One of the difficulties in the

construction is to make the molten substance stick fast to the electrodes. The selenium appears to combine to some extent with the surface of the metal on which it is deposited when in a molten state, forming an extremely thin layer of selenide; this, however, is brittle when cold and extremely liable to chip off. If the copper or brass is slightly tinned, the adhesion of selenium is facilitated.

After the selenium has been successfully laid over the electrodes in the form

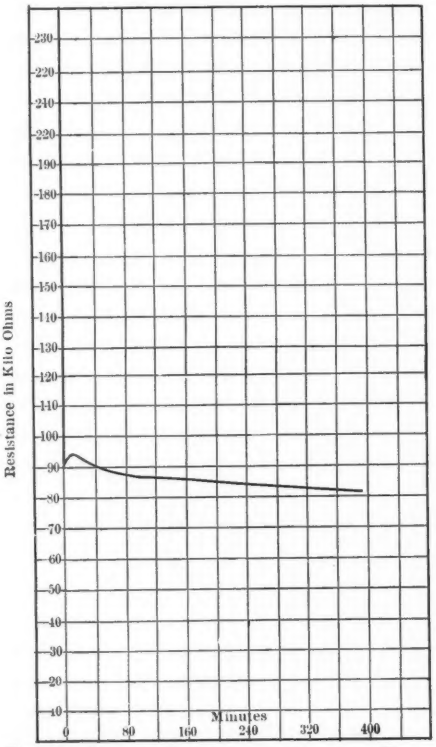


FIG. 4.—CURVE SHOWING EFFECT OF PROLONGED EXPOSURE TO LIGHT. RESISTANCE USED OF TYPE SHOWN IN FIG. 1, COATED WITH PURE SELENIUM.

of a thin sheet, the resistance thus formed should be baked in an oven at a temperature of approximately 190 degrees centigrade for a period of three hours, after which it should be slowly cooled; this process occupying possibly another three hours.

Fig. 2 shows the result of baking a resistance formed of vitreous selenium. The treatment was imperfect. It will be seen from the curve A that the material went over into the crystalline form at a temperature of about 170 degrees. In this experiment, readings for which are given in table i, the selenium was maintained at about 180 degrees for an hour and a quarter, and on cooling it was found to be sensitive to light.

Fig. 3 illustrates the result of a second baking on the same resistance. In this case a lamp was placed in the oven and the variation of resistance with light was observed at successive temperatures. The results show that at the start the resistance was 100,000 ohms and that there was only a slight sensitiveness to light. As the temperature increased the sensitiveness—indicated by the difference between the dotted curve and the full line curve—

TABLE I.

READINGS.

Time.	Temperature. Degrees.	Resistance in Ohms.
10.50 A. M.	20	.....
11.00 "	70	7,460,000
11.15 "	165	70,000
11.28 "	165	46,000
11.30 "	165	21,000
11.32 "	165	12,300
11.35 "	165	9,540
11.37 "	165	8,870
11.42 "	166	7,880
11.46 "	171	6,700
11.50 "	174	5,600
11.52 "	174.5	5,330
11.55 "	175	4,840
12.00 M.	175	4,730
12.10 P. M.	178	4,270
12.15 "	179	4,150
12.20 "	179	4,030
12.35 "	185	3,280
12.40 "	190	2,770
12.50 "	185	3,080
1.00 "	181	3,590
1.15 "	176.5	4,100
1.30 "	169	4,850
1.45 "	156	6,820
1.50 "	149	7,880
1.55 "	140	10,300
2.05 "	135.5	13,220
2.12 "	124	18,530
2.20 "	116	27,000
2.23 "	115	29,200
3.00 "	31	2,610,000

diminished rapidly, disappearing entirely at about 170 degrees. As shown in table ii, the temperature was maintained at about 180 degrees for a considerable time, and slowly reduced to that of the surrounding air. The curve sheet shows

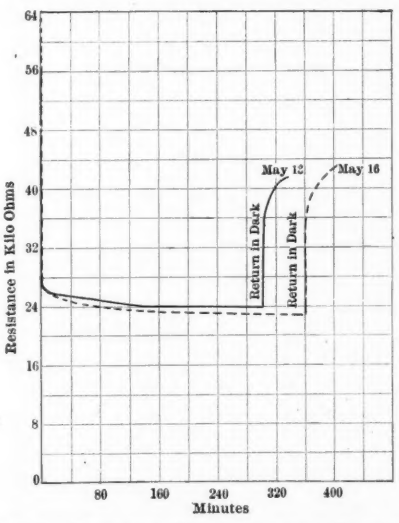


FIG. 5.—EXPOSURE CURVE SHOWING RESULTS OBTAINED WITH A RUHMER RESISTANCE OF THE FLAT TYPE.

that the material began to be sensitive to light on cooling at about 130 degrees, and at sixty degrees there was a marked increase in the reduction of the ohmic resistance produced by turning on the light, and this remained as a permanent property of the resistance. It will also be noticed that the selenium on being cooled slowly did not return to the original high resistance, but that this was reduced to about 37,000 ohms in the dark and 21,000 in the light.

Other similar experiments showed that on cooling slowly the marked increase in

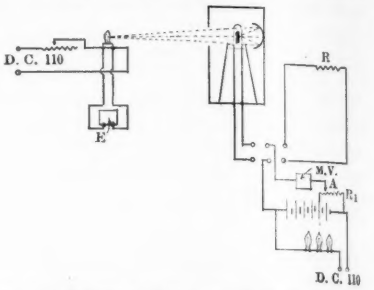


FIG. 6.—RUHMER CELL IN EXHAUSTED BULB IN CONNECTION WITH A PARABOLIC MIRROR.

the difference between the curve for darkness and the curve for light occurs always at about sixty degrees centigrade.

It will be noted, therefore, that the prolonged baking and slow cooling have the effect of reducing the ohmic resistance, and increasing the sensitiveness.

TABLE II.

READINGS.

Time.	Temperature. Degrees C.	Resistance in Darkness.	Resistance in Light.
12.04 P. M.	.....	928,000	230,000
12.16 "	81.5	164,000	140,800
12.20 "	93.5	101,700	94,700
12.28 "	103	44,600	44,500
12.36 "	107	36,000	34,600
12.42 "	111.5	29,100	28,500
12.50 "	118	21,300	21,000
12.58 "	125	17,200	17,200
1.04 "	135.5	13,080	12,880
1.08 "	137.5	11,770	11,600
1.13 "	147	8,280	8,080
1.14 "	155	6,890	6,880
1.15 "	160	6,080	.....
1.17 "	169	4,8.0	.....
1.19 "	170	4,340	.....
1.23 "	172	3,900	.....
1.41 "	175	4,010	.....
1.47 "	182.5	3,010	.....
1.49 "	183.5	3,140	.....
1.53 "	185	3,070	.....
1.55 "	189.5	2,860	.....
1.56 "	192	2,660	.....
5.32 "	189	2,700	.....
5.50 "	173	3,8.0	.....
5.56 "	159	4,570	.....
5.58 "	155.5	4,780	.....
6.01 "	152.5	4,300	.....
6.04 "	147	5,420	.....
6.06 "	141.5	5,930	.....
6.15 "	138	6,890	.....
6.18 "	128	7,880	.....
6.22 "	126	8,220	.....
6.29 "	111	10,760	10,480
6.33 "	102	12,880	12,200
6.37 "	92	15,430	14,220
6.39 "	81.5	18,530	16,250
6.42 "	70	24,000	21,300
6.44 "	64	28,200	24,700
6.45 "	58.5	29,650	27,500
6.47 "	54.5	29,700	21,350
6.50 "	48	33,200	22,150
6.54 "	42	36,000	22,200
6.57 "	36	36,600	21,250
7.05 "	31	37,200	21,400

Experiments were carried on to determine the effect of slight impurities in the selenium used, and it was found that one or two per cent of copper selenide or nickel selenide could be present without affecting to a marked extent the sensitiveness of the resulting resistance.

The idea of using a sensitive resistance for the purpose of measuring light is a

very attractive one in that it involves reducing photometry to a mechanical process. The reading of a current indicating instrument being substituted for the opinion of the observer would make the results more definite. The main difficulty lies in the fact that selenium is more sensitive to some wave lengths than to others; therefore, at present, it seems difficult to use selenium as a light standard. It can, however, be used for purposes of comparison between similar lights. Its properties in this respect can be judged from the results to be described.

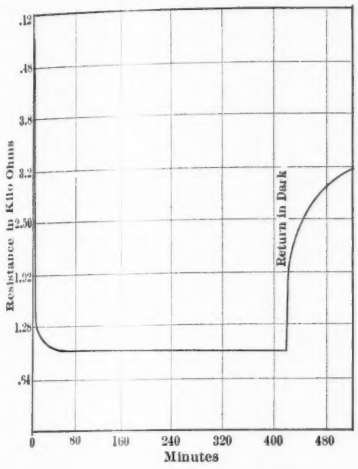


FIG. 7.—EXPOSURE CURVE OF A CYLINDRICAL TYPE RUHMER RESISTANCE ENCLOSED IN AN EXHAUSTED BULB.

Fig. 4 gives the variation in the resistance during exposure to light in a plate made of pure selenium; an incandescent lamp was used, giving seven candle-power, its voltage being maintained constant. The distance between the surface of the selenium and the axis of the lamp was forty centimetres. The curve illustrates the characteristic behavior of selenium during exposure to light. A kind of fatigue appears to exist in the sensitive material, and, as the time elapses, the ohmic resistance drops at a nearly uniform, though slow, rate for a very long time. This is apparently not due to a change in temperature, because the temperature of the resistance undoubtedly reaches a constant value well inside of 400 minutes on account of the small mass and large radiating surface. The curve shows the characteristic sudden decrease in resistance when the light is turned on at zero time.

The construction used in this case was that shown in Fig. 1; it was employed mainly because it enabled the same frame to be used for a series of tests. A wire-wound resistance gives better results because the adhesion of the material is stronger, and the flow of current is more along the surface on account of the fact that the material sinks down between the wires.

Fig. 5 shows results obtained with a selenium plate made by Ruhmer; it shows the same slight decrease in ohmic resistance during exposure to light, and also indicates the gradual way in which the resistance recovers on turning off the light. Complete recovery requires twenty hours.

It was found that under the proper conditions the same curve between time and candle-power can be obtained from day to day at the same temperature, and this matter was investigated quite thoroughly.

A cylindrical Ruhmer cell contained in an exhausted bulb was used in connection with a parabolic mirror. The source of light was maintained at a distance of 150 centimetres from the selenium.

The connections were as shown in Fig. 6, in which a double throw switch is used to compare the reading of the millivoltmetre when connected to the selenium resistance with its value at the same voltage when connected to the adjustable ohmic resistance R.

Fig. 7 shows a curve giving the behavior of a cell of this type during exposure to light. It will be seen that the change between the resistance in the dark and in the light is very great, and that there is a slight variation in the value of the resistance during the exposure. It was found that the time during which the selenium had remained in the dark, the intensity of the light to which it had been previously exposed and other conditions affected the curve thus obtained, and it was necessary to determine some method by which the same reading of resistance could be reproduced by the same candle-power from day to day.

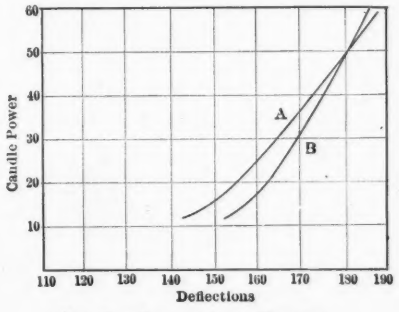


FIG. 8.—CALIBRATION CURVES.

After trying several methods, the following was found to give very good results: having allowed the resistance to stand in the dark for about twenty hours, the battery current is then sent through the selenium resistance after the voltage has first been adjusted to the desired value, by noting the deflection obtained, using the resistance R in Fig. 6. This voltage was then maintained constant, and the double throw switch was allowed to remain thrown, so as to connect the battery permanently to the selenium resistance. This is kept in the dark with the current flowing through it for ten minutes. At the end of this time it is exposed to the first lamp, and at the end of five minutes the reading of the millivoltmeter is taken; the light is cut off at the end of five minutes' exposure, and the deflection is allowed to drop to some value above the minimum deflection which would be obtained by keeping the resistance permanently in the dark. In this case the deflection dropped to 100, the minimum deflection corresponding to permanent darkness being in the neighborhood of eighty-four.

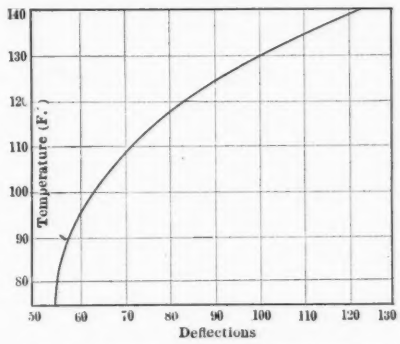


FIG. 9.—CURVE SHOWING TEMPERATURE VARIATION IN CONDUCTIVITY.

Upon reaching this value the selenium was exposed to the next light in the series for five minutes, and then darkened. The deflection having been again allowed to drop to the same value as before, it was exposed to the next succeeding lamp for five minutes. In this method, each successive lamp must be of a higher candle-power than the preceding, and the results obtained furnished a calibration curve, which is indicated by the letter A in Fig. 8, and it is possible to reproduce this curve from day to day.

The method described, however, is altogether too slow for convenient use, and it would be impossible to be sure that after testing one lamp the next one would be higher in candle-power.

The second method will overcome this difficulty, and is as follows: The resistance is exposed to a high candle-power lamp for about forty-five seconds, and the deflection is then allowed to drop in the dark to a value somewhat above that used in the case given before. This value was taken at 110. When the deflection

reaches this value, the resistance is exposed to the first light of the series for five minutes; it is then darkened and the deflection allowed to drop again to 110; this process is repeated for a succession of different lamps.

By this method the curve B was obtained with a number of lamps, and it may be taken as a calibration curve for the selenium resistance in question. The curves A and B illustrate in an interesting way the effect of the different methods of taking readings on the results obtained.

The curve shown in Fig. 9 gives the temperature variation in the conductivity of the same specimen, the readings being taken with the selenium in darkness.

The impression obtained from the results of these experiments is that at present a selenium resistance is hardly as good as the well-known forms of photometer with all their drawbacks, and that at best it should only be used to compare lights substantially similar in color. For measuring the illumination of a room, however, it is extremely convenient and quite accurate enough. It is, no doubt, possible to increase the value of the selenium resistance as a means of measuring light by further investigation and development. The difference between the results obtained with a crude construction, as shown in Fig. 4, and an improved type of resistance which gave the values of Fig. 7, indicate what can be done in this way, and there is at least reason to hope that when as much time has been spent upon the development of a selenium photometer as on that of prevailing types, very different results may be obtained.

The experiments described were carried on in the laboratory of the Electrical Engineering Department of Columbia University, and the writer desires to acknowledge the assistance of Messrs. J. E. O'Shea, M. Palmer, C. Baumgarten, C. F. Strong and G. W. Hochsprung, students in the Department, who have assisted in carrying on the experiments from year to year.

Lake Erie & Western Will Experiment with Electricity.

On the Peoria division, where the competition of the electric surface lines is very keen, the Lake Erie & Western Railroad, belonging to the Vanderbilt group, will install electric motors in an attempt to recover some of its lost traffic. Should this experiment prove successful, it is probable that the Lake Erie & Western will have an electric passenger service for the entire distance between La Fayette and Indianapolis.

THE ASSOCIATION OF EDISON ILLUMINATING COMPANIES.

TWENTY-FIFTH CONVENTION HELD AT NEW CASTLE, N. H.

The Association of Edison Illuminating Companies held its twenty-fifth convention at Hotel Wentworth, New Castle, N. H., August 30, 31, and September 1, 1904.

The meetings were presided over by President J. B. McCall, of Philadelphia. Interest in the proceedings was well sustained, and there was a very complete attendance of the delegates at each session. All the papers on the programme were read and elicited full discussion. President Edgar, of the Boston company, extended an invitation to all the delegates to join in the reception to the foreign electrical engineers in Boston on September 2 and 3.

The attendance was the largest in the history of the association, the following companies being represented by the gentlemen named:

General Electric Company—C. A. Coffin, president; Eugene Griffin, vice-president; Elihu Thomson, Lynn, Mass.; J. R. Lovejoy, manager lighting department, Schenectady, N. Y.; B. E. Sunny, Western manager, Chicago; E. D. Mullen, manager, Philadelphia; Fred M. Kimball, manager small motor department, Boston, Mass.; Charles P. Steinmetz, William LeRoy Emmett, Caryl D. Haskins, Schenectady, N. Y.; Wallace S. Clark, engineer wire and cable department, Schenectady, N. Y.; Walter D. A. Ryan, illuminating engineer, Lynn, Mass.; George F. Morrison, manager lamp works, Harrison, N. J.; A. D. Page, Francis W. Willcox, Harrison, N. J.; Sidney B. Paine, Boston, Mass.; George H. Stickney, assistant illuminating engineer, Lynn, Mass.; Charles A. Mosman, A. L. Rohrer, W. S. Andrews, Schenectady, N. Y.; Clyde A. Houghton, Lynn, Mass.; Martin J. Insull, Pittsfield, Mass.; Harry J. Buddy, Philadelphia, Pa.; P. D. Wagoner, H. W. Hillman, E. E. Gilbert, Schenectady, N. Y.; H. C. Wirt, engineer supply department, Schenectady, N. Y.; E. H. Mullin, New York; F. N. Boyer, manager supply department, Chicago; F. P. Cox, meter engineer, Lynn, Mass.; Theodore Beran, F. C. Bates, New York.

Edison Electric Illuminating Company, Boston—Charles L. Edgar, president; A. S Knight; William H. Atkins, general superintendent; W. H. Francis, purchasing agent, J. W. Cowles, superintendent of distribution; Herbert A. Wagner, New York; Welles E. Holmes, district superintendent, Newton, Mass.; LaRue Vredenburgh, manager department of publicity, Boston; Sidney Hosmer, superintendent of installation, Boston; Charles H. Parker, assistant superintendent generating department, Boston; Arthur G. Pierce, Boston; Leonard L. Elden, electrical engineer, Boston; Gerhard M. W. Goettling, storage battery engineer; R. S. Hale, Charles H. Merrick, contract agent; John S. Vogler, claims and adjustments; W. P. Hancock, superintendent general department; Charles J. Hatch, special agent; Crawford R. Brown, superintendent of standardizing and testing; F. Ellwood Smith, suburban district manager.

Chicago Edison Company—Samuel Insull, president; Walter M. Anthony, comptroller; Peter Junkersfield, George N. Eastman, Ernest Lunn, superintendent of storage batteries; Robert C. P. Holmes, John W. Ferguson, assistant to contract agent; Edwin J. Fowler, W. G. Carlton, assistant to chief operating engineer.

Edison Electric Light Company, Philadelphia—Joseph B. McCall, president; Joseph D. Israel, secretary and manager; William C. L. Elgin, electrical engineer; William F. Harrity, Charles J. Russell, district manager; John W. Meyer, P. H. Bartlett, superintendent of installation; Howard K Mohr, manager advertising bureau.

New York Edison Company—Thomas E. Murray, second vice-president; H. M. Edwards, Robert A. Carter, A. H. Ackermann, engineer meter and test department; Arthur Williams, general inspector; Walter F. Wells, superintendent Waterside station.

Edison Illuminating Company, Detroit, Mich.—Alex. Dow, vice-president and general manager; Hoyt Post, director and attorney; Samuel C. Mumford, assistant secretary; John W. Brennan, purchasing agent.

Edison Electric Illuminating Company of Brooklyn—E. A. Leslie, second vice-president and general manager; W. W. Freeman, secretary.

New Bedford Gas and Edison Light Company—George K. Stetson, president and general manager; Charles R. Price, treasurer.

G. W. Brine, vice-president and treasurer Georgia Railway and Electric Company, Atlanta, Ga.

Leon H. Scherck, Birmingham Railway, Light and Power Company.

Byron T. Burt, general manager Chattanooga Electric Company, Chattanooga, Tenn.

W. H. Johnson, director Beacon Electric Light Company, Chester, Pa.

Louis A. Ferguson, Commonwealth Electric Company, Chicago.

Mathias E. Turner, Cleveland Electric Illuminating Company.

J. H. Lovejoy, president Des Moines Edison Company, Schenectady, N. Y.

Thomas G. O'Dea, Erie County Electric Company, Erie, Pa.

Harry Bottomley, superintendent Fall River Electric Light Company, Fall River, Mass.

Charles C. Perry, secretary and treasurer Indianapolis Light and Power Company, Indianapolis, Ind.

James B. Foote, Jackson Light and Power Company, Jackson, Mich.

J. W. Reeves, general manager Citizens' Light, Heat and Power Company, Johnstown, Pa.

A. M. Worthington, general manager Louisville Lighting Company, Louisville, Ky.

R. S. Wallace, superintendent Peoria Gas and Electric Company, Peoria, Ill.

W. S. Barstow, consulting engineer, Portland General Electric Company, Portland, Ore., New York.

M. A. Beal, Rockford Edison Company, Rockford, Ill.

W. F. White, Union Electric Light and Power Company, St. Louis (Missouri Edison Electric Company), New York.

William Chandler, Edison Sault Electric Company, Sault Ste. Marie, Mich.

Dwight P. Robinson, engineer Seattle Electric Company, Boston.

G. H. Edes, J. R. Lovejoy, vice-president Edison Electric Light Company, Schenectady, N. Y.

F. G. Sykes, electrical engineer Schenectady Railway Company, Schenectady, N. Y.

D. L. Huntington, second vice-president and general manager Washington Water Power Company, Spokane, Wash.

E. J. Bechtel, superintendent of lighting, Toledo Railways and Light Company, Toledo, O.

H. W. Fuller, general manager Potomac Electric Power Company, Washington, D. C.

Ernest H. Davis, Edison Electric Illuminating Company, Williamsport, Pa.

Wilson S. Howell, Electrical Testing Laboratories, New York.

Clayton H. Sharp, test officer Electrical Testing Laboratories, New York.
W. F. Little, Electrical Testing Laboratories, New York.
Herbert Lloyd, president Electric Storage Battery Company, Philadelphia.
G. H. Atkin, manager Electric Storage Battery Company, Chicago.
John R. Williams, Electric Storage Battery Company, Philadelphia.
Forrest E. Barker, chairman Massachusetts Board of Gas and Electric Light Commissioners, Boston, Mass.
T. F. Flanagan, electrician U. S. Navy Yard, Portsmouth, N. H.

The following officers were elected for the ensuing year:

President, Joseph B. McCall, Philadelphia, Pa.

Vice-president, D. L. Huntington, Spokane, Wash.

Treasurer, Alex Dow, Detroit, Mich.

Secretary, E. A. Leslie, Brooklyn, N. Y.

Assistant Secretary, H. C. Lucas, Philadelphia, Pa.

Executive Committee: Joseph B. McCall, chairman; Samuel Insull, C. A. Brine, Charles L. Edgar, Louis A. Ferguson, John W. Lieb, Jr., D. L. Huntington, Alex. Dow, E. A. Leslie.

THE PROBLEM OF THE TELEPHONE RELAY.

BY DR. JOHN TROWBRIDGE.

The future historian of the rise and progress of telegraphy and telephony in America must devote much space to the invention of the telegraphic relay; and to a consideration of the claims of Morse and of Henry. The relay in the early days of telegraphy seemed all important; but in these days of better electrical engineering it has lost the preeminent regard it had among the early telegraphers. Nevertheless, it has its place and important functions. The wonder is that the sister art of telephony has not followed the progress of telegraphy and has not already its relay.

The tendency of the times is in the direction of improved telephone lines rather than in employing more sensitive instruments on comparatively imperfect lines.

The telephone is generally regarded as a very sensitive instrument even in its practical form; a telephone relay must evidently be more sensitive than the telephone it proposes to relay; many telephone engineers, therefore, doubt whether a relay can be invented, especially when one considers the crepitating and buzzing effects of carbon transmitters. Such engineers, therefore, believe that long-distance telephony must result from improved lines rather than from relay instruments. The cost of such improved lines, however, is enormous and soon becomes prohibitive, and a practical relay is much to be desired from the point of view of economy. From a scientific point of view, it would be of great interest; for the working of such an instrument in transmitting rapid alternations unimpaired or slightly modified, could not fail to increase our knowledge of accoustics. It would also round out the relations of telegraphy and telephony.

I have, therefore, devoted much time to the subject of the telephone relay and have produced an instrument which works on lines of a certain character.

Before speaking of the character of its working, let us consider the problem of the telephone relay more closely. We have said that the telephone is considered a very sensitive instrument. The student of accoustics, however, soon finds that it is a very imperfect instrument compared with the human ear; its working is immensely aided by human intelligence, much in the same way that the gaps in the reproductions of the phonograph and graphophone are supplied by the knowledge of what must be the sequence, and what words must be supplied; much as the foreigner understands the slurring of the German genders or French particles by the American tourist.

The telephone relay, too, must take this imperfect rendering of speech, and being also an instrument with similar parts—that is, being provided with a diaphragm more or less damped by transmitting devices—might put an additional burden on human intelligence.

A telephone relay may work in a laboratory when treated with due consideration and with experimental skill; but in practical use its vagaries will receive no charity; the occupant of a room in the Waldorf-Astoria wishes to communicate with Chicago with the same instrument that he uses to speak to the office in the hotel; and the telephone engineer does not wish to add to the complexity of an already heavily loaded system.

From the engineer's point of view substitution on different lines of different instruments adapted to the peculiar conditions on various lines is not favored either in telegraphy or telephony; in this respect practical methods depart widely from scientific methods. The theoretical electrician adapts his instrument to the conditions of the experiment. When telegraphy and telephony become more refined arts a variation in instruments will probably take the place of the present uniformity.

Turning now to the working of the relay with which I have been experimenting, I will speak of its working without entering into a detailed account of its construction, further than to say that the diaphragm holds a very minute solenoid in a balanced magnetic field and that the diaphragm actuates a transmitter.

The articulation of this instrument used as a relay on all lines within the compass of a laboratory is as good as that of the ordinary telephone; the wonder is that, with its diaphragm loaded, it repeats so well the articulation given to it; for it is a mechanical ear and must superimpose its own gaps upon those transmitted to it. Through the courtesy of Mr. Hammond Vinton Hayes, engineer of the American Telegraph and Telephone Company, the instrument was tried on the line between New York and Boston.

The relay being placed at the middle of the line, a comparison was made of its working with the ordinary instruments used on the line without break. On such a line the working of the relay proved inferior to that of the ordinary telephone with its transmitter.

On such a comparatively short and comparatively good line the conditions were too exacting for this relay; for the original transmitting instruments showed no failure in loudness and articulation. Why should one, therefore, expect to surpass such working by the use of an instrument with the additional impediment of a loaded diaphragm?

In all cases, it seems to me, where any relay method is compared with the working of the ordinary instrument on the unrelayed line, the message must be given to the relay before the electrical energy has fallen too low and before the articulation has, by reason of great capacity and unbalanced conditions, become inarticulate although still loud.

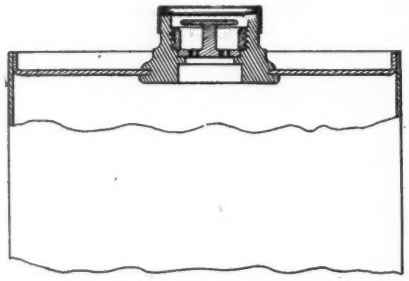
I have experimented with a line representing the distributed capacity of a cable of about forty miles in length, on which the working of the relay surpassed both in articulation and loudness the working of the ordinary telephone instruments. The relay was placed at the middle of the line, the ordinary instruments were used in comparison on the undivided line.

The experiments with the relay on such a line developed the interesting fact that high notes were transmitted better by the relay over half the line, than by the ordinary instruments over the undivided line; a boy's voice was much clearer than a man's deep voice. The attenuation coefficient was less for high notes than for low notes.

With the improvements contemplated in this form of relay there seems to be prospect of its practical use on lines similar in character to that I have described; that is, unloaded lines of considerable length.

Electrical Patents.

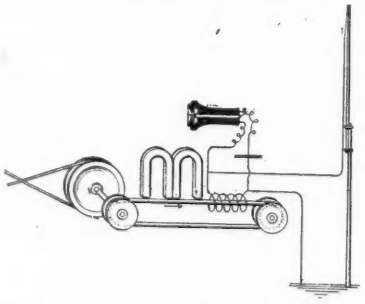
A method of rendering storage battery gases non-explosive has been recently patented by Mr. Thomas A. Edison, of Llewellyn Park, N. J., who has assigned the patent to Edison Storage Battery Company, of Orange, N. J. The can, which is made of thin, nickel-plated steel, is provided with a neck, having a perforated plug therein, and carried by this plug is a deflecting plate for diffusing the gases escaping through the perforations. At the top of the neck is a suitable cooling medium, through which the gases pass. When the apparatus is



METHOD OF RENDERING STORAGE BATTERY GASES NON-EXPLOSIVE.

not provided with special means for effecting the separation of the mechanically entrained globules the gases will escape continuously through the perforations in the plug, but if separating devices are employed the gases will escape intermittently through these perforations. The escaping gases will be deflected outwardly by the deflector, so as to be comparatively attenuated, and they will escape through the cooling medium in a highly rarefied condition. Even if they could ignite on the outside of the medium, the radiating capacity of the latter is sufficient to prevent its becoming hot enough to ignite the gas below it, so that no explosion can take place. This is especially true when the deflector is used, since otherwise there would be danger of a small stream of gas passing directly from each perforation through the medium in a sufficiently concentrated condition as to result in the gauze being dangerously heated.

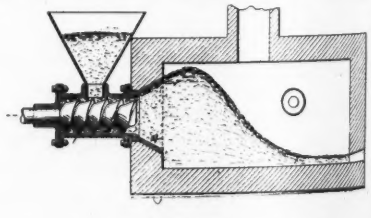
An improvement in wireless electrical signaling has been devised and patented by Mr. Michael Pupin, of New York, N. Y. The invention consists in an improvement of wireless transmission of electrical signals whereby the telephone receiver at the receiving station is brought into syntony with the rate at which the individual spark impulses at the sending end are delivered. In carrying out the invention an alternator is employed, generating an approximately sinusoidal electromotive force of definite frequency. A transformer is provided having a primary and secondary, and also a key, capable of opening and closing the primary circuit of the transformer. A spark-gap is employed, as are also condensers. The secondary of an induction coil is connected in series with the upright wire of a wireless transmitting station. The distance between the electrodes of the spark-gap is such that the difference of the alternating electrical potential impressed upon it will at each one of its maxima points produce a spark between them and set up a series of oscillations in the local circuit. The frequency of the spark delivery will therefore be the frequency of the alternator. These oscillations are transmitted inductively to the upright wire and supply the necessary energy for the electrical waves which are transmitted from the upright wire to space. The condensers and the effective inductance of the primary circuit are suitably adjusted in accordance with the well-known practice. The receiving apparatus may be described as follows: an upright receiving wire is employed. Connected with a suitable small coil is a coil which surrounds the permanent magnet of a telephone receiver. The disc of this receiver is adjusted in such a way as



WIRELESS ELECTRICAL SIGNALING.

to have a definite frequency of oscillation. This frequency is equal to the frequency of spark delivery or of the alternator at the transmitting end or to an integral multiple thereof. Under these conditions, the electro magnetic impulses produced in the local receiving circuit are in syntony with the vibrating period of the movable disc.

An electric furnace to be employed in the treatment of comminuted material from which the metal is to be extracted has recently been patented in this country by Carl Gustaf De Laval, of Stockholm, Sweden. A furnace chamber is employed, also electrodes, between which is produced the electric arc which is the heat focus. An outlet for gases or metal vapors is provided and also inlets for the comminuted material to be treated. The electrodes pass through opposite side walls of the furnace and are located above the hearth. The hearth extends from the end wall to the opposite wall in which is provided an opening, through which the molten material is drawn off. A plurality of inlet openings may be employed, each having its inner end flared or enlarged. Communicating with said openings are cylinders provided with hoppers and internal transport screws. The crushed material is placed in the hopper whence it descends into the cylinders. The screws in said cylinders are then rotated by any suitable means to force said material through the opening and into the furnace. By this construction the material will be fed into the furnace so that it will assume as a resultant of the impelling force and gravity the form of a pile or heap, which lies between the electrodes and the inlet openings. This pile will also have a sloping or inclined face toward the heat focus and will diminish in thickness measured vertically from the hearth until it becomes thinnest at the edge of the hearth and below the electrodes. The material is to be fed through the openings at such a rate as will maintain the slope at such a distance from the heat focus that no sudden development of gases will occur sufficient to materially disturb or displace the material at the surface by causing it to fly about, and, further, so that a layer of half molten material will be produced on the slope surface which will move slowly down the same, while the volatile ingredients which are liberated will escape at the outlet. The new material which is pushed in, forces the pile toward the electric focus; and this pushing forward is to be so timed and regulated as to maintain the slope at proper distances from said focus. The outlet opening is so placed that the volatile ingredients escape through it without passing through

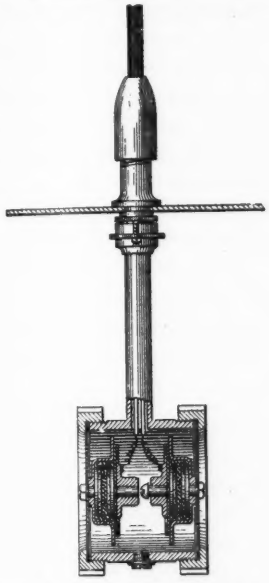


ELECTRIC FURNACE.

the electric focus, which would raise their temperature.

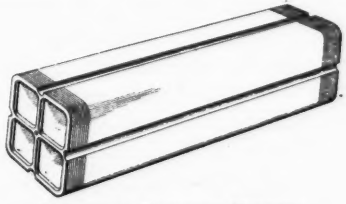
Mr. Arthur J. Mundy, of Boston, Mass., has assigned to the Submarine Signal Company, a corporation of Maine, a patent recently granted him on an improvement in sound transmitters and receivers. It has heretofore been thought necessary

that the diaphragm of the receiving transmitter should be in direct contact with the medium by which the sound was being transmitted, and to do this it has been necessary to adopt apparatus having inconveniences and faults commensurable to those sought to be avoided. The receiving instruments have been suspended directly in the open sea or mounted in the sides of ship, the unprotected diaphragm being in all such instances liable to damage from floating and other obstacles. Mr. Mundy has discovered that it is possible to encase the transmitter without injuriously affecting its responsiveness to sound waves and by the shell of the casing to protect it from damage from exterior agencies. The side of the ship may constitute a portion of such a protecting shell and the ship may constitute the casing. In such case, the use of a transmitter entirely within the ship is provided for. In the location of the transmitter upon shipboard there is employed within the ship, and preferably against the side thereof, a tank, the shell or side of the ship preferably acting as one wall of the tank. Within the liquid of this interior tank the receiver is suitably suspended and the transmitting medium between the same and the sound-producing means without is practically continuous. The medium within the tank and with which the transmitter is in contact has the important function of insulating the transmitter from noises of local origin, such as traversing the frame and sides of the ship have heretofore interfered with and confused the actual signals in instruments where the transmitter has been mounted directly in or on the walls of the ship. Such noises are not delivered to the liquid of the tank in such a way as to affect the transmitter suspended therein; but the signal waves, striking the side of the ship, pass through and into the tank, where they are collected by the transmitter and delivered to the operator.



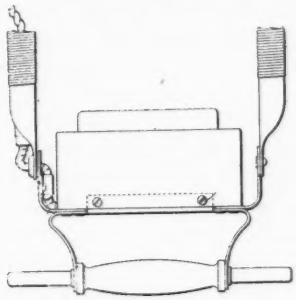
Sound Transmitter and Receiver.

Charles E. Wilson, of Philadelphia, Pa., is the inventor of a sectional electric conduit, the object of which is to furnish an economical underground conduit-section for electrical or other purposes which can be evenly and firmly laid, the parts of which are reversible or invertible and which by duplicating the parts can be made to form a composite conduit of any desired capacity. In the embodiment of the invention, the conduit-section is formed of baked clay. It is approximately square in cross-section with the corners rounded. It is divided by longitudinal median partitions into four independent ducts, each of about one-quarter of the capacity of the entire conduit-section and all similar in shape. Opposite the points where the partition-lines meet the outer walls of the conduit-section are formed four semi-circular grooves running from end to end. To form a composite electrical conduit, the conduit-sections are laid in courses alongside of and on top of each other to whatever extent may be desired until the desired capacity is reached. In doing this, the alignment of the conduit-sections is maintained by laying them so that the joints of adjacent courses are in a staggered or alternating relation to each other after the manner of brick-laying, and by inserting at convenient intervals along the grooves, liners, which may consist of small cylindrical alignment-pins.



Sectional Electric Conduit.

Tycho Val Aller, of Schenectady, N. Y., has assigned to General Electric Company a patent recently obtained by him on an electrically heated tool. In carrying out the invention an electric suspender connected to the lower ends of which is an electrically heated tool, pivoted about an axis below its centre of gravity, so that when released from the hand of the workman, it is drawn above the work and rotates in inverted position, is attached to a support over the workman's bench. The tool consists of a core of solid metal, about which strips of asbestos or other heat-resisting insulation and resistance wire are wrapped in the usual manner. One edge of the core projects through a grid forming the lower end of an enclosing casing, and the other edge is rigidly secured to a transverse division-plate provided with binding-posts for the electrical connections and secured to the sides of the casing by the screws which secure the upper end-plate in place. The electrical conductors are led through the upper space within the casing between the transverse plate and the upper end-plate to the binding-posts, and in case access thereto is desired, it is only necessary to remove the screws holding the upper end-plate in position. The upper plate has two sets of lugs and projections at its ends. One set of lugs is bent up to receive a handle, while the other set is bent down beyond the longitudinal axis of the tool and pivotally connected to the lower ends of the elastic suspender. The handle is made with one or more longitudinal projections adapted to engage the suspender and prevent successive rotations of the tool on its pivoted axis to thereby protect the electrical feed-wires from becoming unduly twisted.



Electrically Heated Tool.

Among other patents issued August 16, 1904, are thirty-six granted to John S. Stone, of Cambridge, Mass., on apparatus for wireless or space telegraphy. One of these patents has been assigned to the Stone Telegraph and Telephone Company, of Portland, Me., and the remainder are in the hands of W. W. Swann, trustee, of Brookline, Mass.

The Use of Oil for Fuel.

The Southern Pacific Railroad Company has recently completed changes in its shops at Sacramento, Cal., permitting the use of oil for fuel instead of coal. Changes in all of the company's locomotives are gradually being made, so that eventually oil will be the only fuel used. The company, it is said, has recently purchased large oil fields in southern California.

Reviews of Current Engineering and Scientific Literature.

Improving Hard-Rubber Insulators.

In the study of currents through air, quantities to be measured are so small that any leakage of the insulators introduces a serious error. For such instruments amber makes an excellent insulator, except that it is brittle and is expensive when in large pieces. Hard rubber is an excellent material if surface leakage can be prevented. A method of doing this is described in this note by Herr H. Schering. Posts made of hard rubber should have a number of deep slots cut in them. This increases the length of the leakage path over the surface. But it is desirable to protect the post thus made from mechanical injury and dust, and it should be surrounded by some form of shield. Insulating posts which must be handled frequently should have a deep, sharp thread or a series of grooves cut in the surface. When this is done the hand comes in contact with only the outer edge of the ridges thus formed, and moisture is not transferred to the bottom of the grooves. Insulators constructed by this method have been used satisfactorily for many delicate instruments.—*Translated and abstracted from the Physikalische Zeitschrift* (*Leipsic*), *August* 1.

The Influence of Grounding the Neutral Point of a Three-Phase Distributing System on the Loss of Power in the Dielectric of the Cable.

The effect of grounding the neutral point of a transmission system upon the dielectric loss in cables has been investigated by M. Humann in the laboratory of Felten and Guirneaume Carlswerk Actiengesellchaft at Mülheim on the Rhine. The experiments were made on a cable 890 metres long, having three cores, each twenty-five square millimetres in section. The insulation of the three conductors and that between them and the lead sheathing is a layer of impregnated paper 6.8 millimetres thick. For the test a high-tension transformer was used, one terminal being connected to the conductors and the other to the sheathing. Upon earthing the centre the lost power in the dielectric in watts per kilometre with a voltage of 5,000 was 26.3. When one phase of the system was grounded, the loss increased to 40.2 watts per kilometre. For 10,000 volts the losses were respectively 105.3 and 160.5 watts per kilometre. This indicates that the dielectric loss is diminished when the neutral point is grounded.—*Translated and abstracted from l'Industries Electrique* (*Paris*), *August* 10.

The Life of Incandescent Lamps.

In this article, the opportunity for improving the incandescent lamp is dwelt upon, surprise being expressed at the apparent indifference of incandescent lamp users to the quality of the lamps which they purchase. As has been frequently pointed out, the greatest room for improved efficiency in electric lighting lies with the lamp, and not with boilers, engines and dynamos. There is no doubt whatever that great improvement is possible in the incandescent lamp as it is now known, but there seems to be little real competition between the makers, except in the matter of price, and it is very doubtful whether this is to the interest of the consumer in the long run. Many tests of lamps are made each year, though the results of but few are made public, and these are usually in such shape as to be of little value to any one except the person who made the test. It is believed that all lamps are made in substantially the same way, out of the same or similar materials, and when different results are obtained it is due to the method of handling the material at some stage or other. Each maker has some wrinkles of his own which he probably thinks of great importance. If all these wrinkles could be thrown together, it is probable that some real progress would be made.—*Abstracted from the Electrical Magazine* (*London*), *August*.

The Effect of Radium Rays on the Colon Bacillus, the Diphtheria Bacillus and Yeast.

An investigation has been made by Mr. S. C. Prescott, of the Biological Laboratories of the Massachusetts Institute of Technology, to determine the effect of radium rays on various bacilli. It has been asserted by various investigators that typhoid bacilli and lower organisms are destroyed by the action of radium rays. To test this, exposures lasting for various lengths of time, and with the tube containing radium at different distances from the culture, were made. A careful scrutiny of the culture failed to show that radium had any action on typhoid bacteria. A similar treatment of the diphtheria bacteria gave only negative results, and experiments were made with yeast without revealing any destructive effect of the radium rays on the life or growth of the micro-organisms. The conclusions drawn are that radium rays have no effect upon fresh cultures of these bacteria when the tube is at a distance of one centimetre, and the time of exposure is less than one hour and a half; therefore, any advantages derived from the therapeutic use of radium must be explained in some other way than by the direct weakening or distortion of the micro-organisms of disease. The use of radium tubes in the treatment of diphtheria is not recommended as a substitute for antitoxin.—*Abstracted from Science* (*Garrison-on-Hudson*), *August* 19.

The New Factory of Siemens Brothers & Company at Stafford, England.

The well-known firm of Siemens Brothers & Company, Limited, was one of the pioneers in the British electrical engineering industry. This company has recently erected an entirely new factory at Stafford, for the manufacture of all apparatus pertaining to the heavier branches of electrical engineering. The firm has for the last forty years been associated with Woolwich, where the large Siemens works have been established since the commencement of their activity. The new works are built on a site of fifty acres, and comprise, in addition to the offices, the following buildings: a machine shop 280 feet long and 270 feet wide, arranged in eight bays, four of which are provided with galleries; an erecting-shop 478 feet long by 115 feet wide, arranged in three bays, and provided with an annex for the boiler-house, water purifying plant, etc.; a wood-working shop 120 feet long by 100 feet wide; a small foundry eighty by fifty feet; a small gas works, producing water gas for use in the shops and in various furnaces. The offices consist of a handsome block detached from the works, and afford accommodation for the clerical and technical staffs. The works are laid out on the most modern lines in successive bays, with saw-tooth roofs lighted from the north. A railway runs down the ends across the whole of the bays, with branch lines down each bay. The shop is so arranged as to afford a

minimum handling of material, the finished parts passing continuously forward from start to finish.—*Abstracted from the Electrical Review (London), August 19.*

The Principles and Practice of Superheating.

Superheating, both in principles and practice, is, according to Mr. W. H. Booth, very little understood by the majority of engineers. The author discusses the thermodynamics of steam, showing that, per pound, dry saturated steam at the same temperature as superheated steam contains more heat units than the latter, and should therefore be a better working fluid. This would be the case were it possible to use the steam adiabatically. It is the impossibility of working under this condition that makes superheated steam more economical than saturated steam, the superheat of the former acting merely to prevent cylinder condensation. The steam which works in the cylinder is not superheated. It becomes saturated by the time cutoff takes place. Superheat, in fact, effects its purpose in the act of its own sacrifice. Thermodynamics have no part or lot in superheat, and none of the economy of superheat arises from widening the range of temperatures between which the steam works. The author then considers the difficulties which have been encountered in using superheated steam, the first trouble being cylinder lubrication. The admission valves gave a good deal of trouble, though we are learning to overcome this. Superheat is a remedy for the faults and losses which arise because steam engines are not constructed of materials which behave as do the materials of the engines on which text-book calculations are founded. Actual engines are brought nearer to the condition of such ideal engines by means of superheat than any other means yet practiced or considered.—*Abstracted from the Tramway and Railway World (London), August 11.*

Electric Lighting of Railway Trains.

In this article M. L. Munch considers the advantages of the electric lighting of railway trains, as compared with other systems, and dwells at some length upon the advantages of the axle-light systems. The first method of lighting trains by means of electricity attempted was to use a generator placed in the baggage-car or on the locomotive, driving this by means of a steam engine furnished with live or exhaust steam from the locomotive. The originators of this system attempted to develop it along lines which had been successful in braking and heating railway trains. It has had careful trials in several countries, but it is everywhere being replaced by one of the so-called axle-light systems. The factors working against the success of the former system are the varying size of the trains on any one system, and the desirability of exchanging cars between several systems which are not likely to use the same method of lighting. The successful lighting of cars is considerably more difficult than heating or braking, and conditions which are satisfactory for the latter will not give satisfactory illumination. The engineers also attempted to avoid the multiplication of apparatus, involving a greater risk of breakdown and a greater expense. The question is to find a system which will operate uniformly. This is secured by the axle-light systems, which have the further important advantage of making each car entirely independent of all others. It has resulted from this that those companies which have developed the single unit system are now replacing this by the axle system.—*Translated and abstracted from L'Éclairage Électrique (Paris), August 13.*

The Northeastern Railway, England, and the Carville Power-House.

In this section of the detailed description of the Northeastern Railway electric developments, the running equipment is taken up. The first application of electric motor power for freight service is being made on the quay-side branch. This consists principally of a tunnel about three-fourths of a mile long, and the work there is to do away with the steam locomotives used at present. There will be some two and one-half miles of sidings at either end, equipped with overhead conductors. Within the tunnel a third rail will be used. Each locomotive is capable of starting a train of 150 tons on the maximum grade, about one in twenty-seven which occurs in a very sharp curve, and will be able to draw this train at a speed of from nine to ten miles per hour. On the level they will be capable of starting a train of 300 tons and drawing it fourteen miles an hour. Each locomotive is to be fitted with four General Electric fifty-five motors and controlled by a method similar to that used on the passenger cars, except that the automatic acceleration feature will not be provided. In order to save the passenger service, two baggage cars are being equipped with motors. These cars will handle nearly all of the ordinary baggage and will, in addition, be able to draw cars containing perishable freight. They are designed to move at a speed equal to that of passenger cars. The general power station at New Castle is furnishing power to various industries located at that point, where there is a large field for electric development. Rapid progress has been made in this direction, the power for the present being supplied to motors aggregating 6,500 horse-power. One of the largest installations is that of Messrs. Hawthorne Leslie St. Peter's works, where there are no fewer than thirty-five motors, of the three-phase induction type, varying from two to seventy-five horse-power each and aggregating 214 horse-power. There are here sixteen electrically driven cranes, four of them being operated by single motors.—*Abstracted from the Electrician (London), August 12.*

The Electric Arc.

A study of the electric arc at pressures less than one atmosphere has been made by Mr. C. D. Child. The work was carried out with a special form of lamp adjusted by hand, the carbons being mounted on iron rods and inserted in a glass globe made air-tight by means of rubber stoppers. The rod carrying the lower carbon is passed through a glass tube eighty centimetres long, filled with mercury, by which arrangement it is possible to change the length of the arc at will without admitting air. An exploring wire for measuring potentials was inserted in the same manner. These measurements show that with varying pressures the drop of potential at the cathode passes through a maximum of about 100 millimetres of pressure, then decreases, the larger part of the change occurring below thirty millimetres pressure. The drop at the anode decreases uniformly as the pressure decreases, the rate being greater below fifty millimetres. There is no change in the electric force between the electrodes until a pressure of fifty millimetres is reached. Below this it decreases, being approximately one-half as great at two millimetres as at atmospheric pressure. The temperature of the arc is apparently less at low pressure than at high, though with a pressure of one-half millimetre platinum wires still fused. The discharge from the arc to the surrounding cylinder increases rapidly as the pressure decreases. The discharge carried by the positive ions is the greater at atmospheric pressure, that carried by the negative the greater at low pressures. It is pointed

out that a hot anode is not an essential requirement in the theory of the arc. It is believed that the number of ions leaving the electrodes is not as great as that passing through the centre of the arc. A high temperature is an essential requirement for ionization within the arc, except when the pressure is low; then the free path of the negative ions may be sufficiently great to cause ionization by impact.—*Abstracted from the Physical Review (Lancaster), August.*

The Work of the Reichsanstalt in 1903.

This article gives a somewhat detailed review of the work of the Physikalische Technische Reichsanstalt during the year 1903—the sixteenth year of its existence. The staff consists of forty scientific members and assistants, forty-seven mechanics, ten clerks and fifteen attendants. The fees for testing during the year covered by the report were nearly $15,000, a sum which covers but a small fraction of the expenses. The report takes up the work done by the different departments, these covering heat and mechanics, optical research, electric thermometers, pressure indicators, photometry, saccharimetry, metalloptric researches and chemistry. In the electrical department Holborn and Austin investigated the destructive effect of glow discharge on cathodes. In air this is proportional to the chemical equivalent and to the potential difference. In hydrogen atmospheres the phenomena are less regular. Kohlrausch and Grüneisen have made exact determinations of the electrical conductivities of very dilute aqueous solutions of salts of bivalent metals. Pure water, radiated upon through a glass wall by radium salt, increased its conductivity in two days by 0.01 by 10^{-6}, and afterward at a slower rate. The same increase would result if, in the same quantity of water—twenty-five cubic centimetres—one milligramme of salt was slowly dissolved within a period of ten or twenty years. The bureau has established five standardizing stations, and the sixth will soon be opened at Frankfort. Standard resistances of manganin and mercury have for six years kept steady within one part in 2,000. This department during the year made commercial tests of a large number of galvanometers, meters, rheostats, standards, etc., and it has over 100 meters in various works, which are examined at intervals. At Charlottenburg four new dynamos have been installed, which are joined to the three-phase supply in the following way: the currents are rectified by a motor-generator for charging accumulators; accumulators drive a motor-generator yielding phase currents; a synchronous motor drives a direct-current generator; the stator of a three-phase generator is excited by currents of fifty cycles, the rotor being driven by another motor in an inverse direction, so that currents of 100 cycles can be obtained. The Dolezalek electrometer has proved suitable for alternating-current measurements. This instrument has a needle of silver paper. It is very sensitive, but is affected by slight radiations. The optical method of measuring alternating currents has been found reliable with currents of 800 amperes within two parts in a thousand. This consists in heating a piece of platinum foil by direct currents, and then by alternating currents of the same degree of incandescence. Of 107 Clark standard cells submitted, ninety-eight received certificates. All of the fifty Weston cells submitted were passed. The mean electromotive force of the Weston cell is given as 1.0189 or 1.0190. The chief task of the magnetic laboratory did not advance much. This is the comparison of the methods for wattmetric magnetic testing, but it was found that the alternating-current generator which has been intended for this work and which contains no iron, no longer gave purely sinusoidal pressure curves when loaded with iron rings. A generator was then secured from Siemens & Halske, in which this trouble was small and could be allowed for. The experiments so far confirm previous experience. The apparatus of Epstein and Möllinger can be recommended. Richter's apparatus for testing large sheets gives values which are a little too high. Brion's apparatus gives values decidedly too low. Some of the magnetic materials tested show high ohmic resistance, with excellent magnetic properties. Low maximum permeability generally goes together with low-starting permeability in weak fields, but this does not apply to high permeabilities. In photometry many lamps of different types were tested. The current consumption of colored arcs was, in the best case, 0.37 watts per Heffner candle. The enclosed arcs were unsteady and uneconomical. The osmium lamps required thirty-eight volts, and proved very economical during the duration of tests, 2,000 hours. A number of electric incandescent lamps have been tested as secondary standards by the Reichsanstalt, by the Electric Testing Laboratories, by the Paris Laboratoire Central, by the National Physical Laboratory, London, and by the Ediswan Laboratory, London. The results were not quite satisfactory. The International Photometry Commission, which was nominated at the Paris Exposition of 1900, and which assembled last June at Zurich, has sanctioned a number of ratios, notably the ratio of the Carcel to the Heffner as 10.9. The ratio of the Harcourt ten-candle-power pentane lamp to the Heffner is 11.4.—*Abstracted from Engineering (London), August 5.*

American Institute of Electrical Engineers.

ASSOCIATES ELECTED WEDNESDAY, AUGUST 17.

H. Allcock, Manchester, England.
Robert T. Andrae, Schenectady, N. Y.
John Irvin Beggs, Milwaukee, Wis.
Tom W. Bevan, Sao Paulo, Brazil, S. A.
Charles Bunje, Jr., Jersey City, N. J.
John Francis Card, Three Rivers, Mich.
Louis Cassier, New York city.
Louis A. Cressy, West Hartford, Ct.
Walter Melville Dann, Wilkinsburg, Pa.
Jose Maria Garza, Schenectady, N. Y.
Albert Earle Hayes, Lynn, Mass.
Halbert Paul Hill, St. Louis.
W. H. Hill, Brooklyn, N. Y.
Walter E. Holland, East Orange, N. J.
Alfred C. Holtby, Johannesburg, S. A.
William Hoopes, Pittsburg, Pa.
Torsten Holmgren, Stockholm, Sweden.
Sydney Richard Inch, Missoula, Mont.
Arion S. Kalenborn, Tacoma, Wash.
Leonard Kebler, Bronxville, N. Y.
Carl Jackson Kiefer, Cincinnati, Ohio.
Albert Joseph Kohler, Lynchburg, Va.
Xavier A. Kramer, Magnolia, Miss.
David Leonard Linquist, Yonkers, N. Y.
Albert Stewart Lindstrom, St. Louis, Mo.
Frank W. Linebaugh, Ames, Iowa.
Rafael E. Martinez, San Francisco, Cal.
William Norman McAnge, Jr., Suffolk, Va.
Thomas Leonard Morrill, Bisbee, Ariz.
E. Vernon Murphy, Baltimore, Md.
H. Van Houten Neefus, East Orange, N. J.
Percy T. Owen, Melbourne, Australia.
Ellery B. Paine, North Woodstock, Ct.
John C. Parker, Niagara Falls, N. Y.
Robert Parker Parrott, New York city.
Ashley Pomroy Peck, Milwaukee, Wis.
Gian Giacomo Ponti, Pittsfield, Mass.
George Ely Quinan, Electron, Wash.
Charles J. Quinn, Jr., Brooklyn, N. Y.
William Edgar Richards, Toledo, Ohio.
Lewis Taylor Robinson, Schenectady, N. Y.
James A. Scott, Niagara Falls, N. Y.
John Aitken Shaw, Montreal, Canada.
Ferdinand Sieber, Philadelphia, Pa.
Albert Boynton Storms, Ames, Iowa.
David Maxwell Swink, Durham, N. C.
Richard Henry Thomas, New York city.
Philip Henry Trout, Staunton, Va.
Charles Emory Warner, Pittsburg, Pa.
Matthew F. M. Werth, Lynn, Mass.
J. William White, Arlington, Mass.
T. von Zweigbergk, Southport, England.

ASSOCIATES TRANSFERRED TO THE GRADE OF MEMBER.

Louis Aloysius Ferguson, Chicago, Ill.
Thomas L. Miller, Liverpool, England.
Howel H. Barnes, Jr., Pittsfield, Mass.
Ernest Gonzenbach, Youngstown, Ohio.

The Automobile Club of America has compiled and issued in book form the automobile laws of all the states of the United States. This will undoubtedly prove of great value to tourists.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Telpherage Plant at the Walter Baker Mill at Milton, Mass.

The telpherage plant recently installed by the United Telpherage Company in the Walter Baker Chocolate Company's mills at Milton, Mass., views of which are here shown, presented some unusual difficulties in construction. The only level ground traversed by the track is for a distance of sixty feet. There are two curves, one ninety degrees of forty feet radius, shown in Fig. 1, the other ninety degrees of twenty feet radius. The track passes along the side of a cliff and across a swift-running river at an elevation of fifty feet, on a steel bridge. The portion of the track on level ground is supported by A bents, thirty-five feet above the ground on concrete foundations. Fig. 2 shows the construction of one of these. Along the cliff, Georgia pine posts fourteen inches square are used. Foundations for these posts were cut out of the face of the rock and are braced in the shape of a figure four by heavy timbers, also anchored in the rock. This construction is shown in Fig. 3. Foundation piers for the tower which support one end of the steel bridge, are built on the slanting rock of the river bank of concrete. The top of this tower is fifty-five feet above the water, and the distance between the tower and mill is eighty feet. This distance is covered by a heavy steel bridge, carrying the track beneath it. The track is entirely free of snow blockades in winter. Before this plant was constructed the method of handling was to truck all the raw material, by a number of teams from the freight-house by a roundabout route to the mill, where it was hoisted to the third floor on elevators. The present method reduces the distance and many of the difficulties. Bags of cocoa weighing about 300 pounds each are loaded nine on a truck in the freight-house. Three trucks are then hitched to the machine, raised clear of the floor and deposited on the floor of the mill in less than one minute. Besides the controller a brake handled by the operator brakes both the telpher and trailers so that the train can be stopped in its own length. The trains are thirty feet long and the average speed 700 feet to the minute. The weight of the truck is 4,600 pounds, and with three loaded trucks the total moving load on the structure is about 12,000 pounds. One man at two dollars a day does the work which previously required numerous men and animals. The power consumed by the telpher costs about one dollar for a ten-hour day.

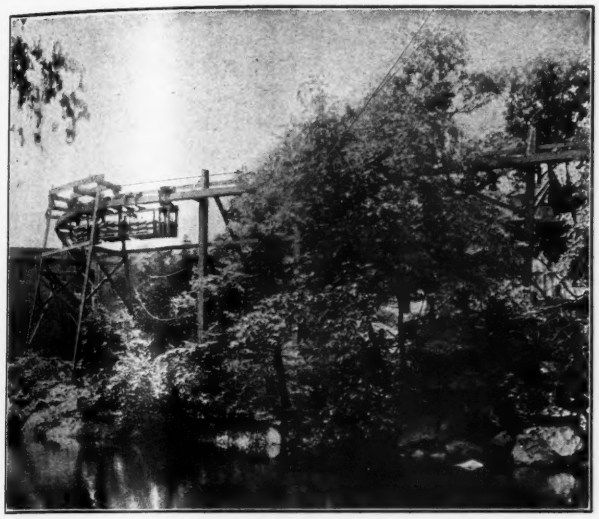


FIG. 1.—THE FIRST CURVE, 90 DEGREES AND 40 FEET RADIUS.

FIG. 2.—DETAILS OF TOWER SUPPORTING THE STEEL BRIDGE.

FIG. 3.—CONSTRUCTION OF THE LINE ALONG THE SIDE OF A CLIFF.

The Wireless in Business Enterprises.

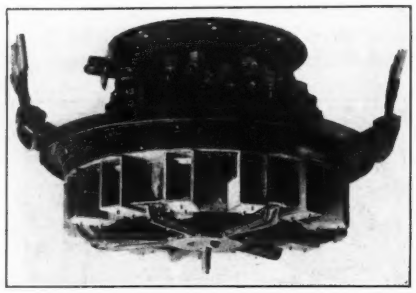
Probably the first use of wireless telegraph in soliciting business was that made by Mr. Frank A. Burrelle, of press clipping fame. Last week several notable passengers on an inbound steamer, while still several days at sea, received telegrams asking if they wished press clippings on their arrival. Mr. Burrelle feels that he could supply press clippings on the day of their publication to customers in mid-ocean, if necessary.

German Coal in France.

German coal is being used in France and sold at a considerably less price than the English. This coal comes from the mines of Westphalia. It is floated down the Rhine at a very low freight rate to Rotterdam on scows, and freighted from Rotterdam to Havre on Dutch ships. Its price f. o. b. at Rotterdam is from $1.93 to $2.04 a ton; delivered at Havre its price is about $3.45, including custom duties, or about thirty-nine cents a ton cheaper than English coal.

The Westinghouse Unit Switch System of Multiple Control.

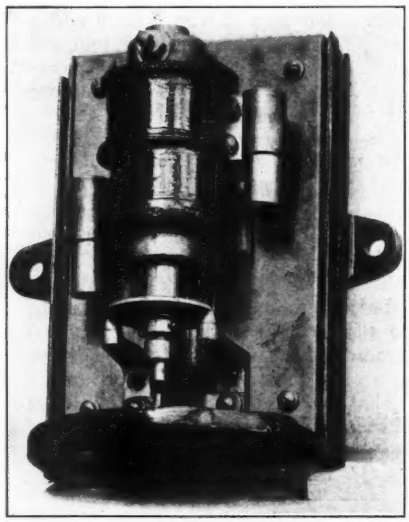
The Westinghouse unit switch system of multiple control has been designed to fulfil the demand for apparatus applicable to the controlling of trains of



UNIT SWITCH GROUP, COVER REMOVED.

motor cars, as well as to cars operated singly. The system consists of a skilful combination of electromagnetic and pneumatic devices. In the design and construction of these devices, advantage has been taken of the knowledge possessed by the Westinghouse Air Brake Company and the Union Switch and Signal Company. In a word, the unit switch system of multiple control consists of a controller operated by the motorman, with connecting wires to various air switches on each motor car.

The control equipment comprises a unit switch group, reversing switch, controllers, train



LIMIT SWITCH.

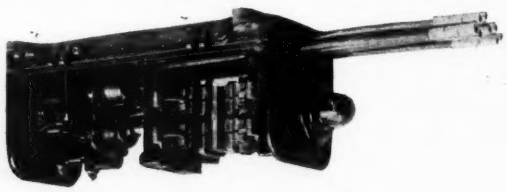
line, diverters, limit and line relay switches, small storage battery and air connections.

A storage battery is the independent source of current for the operation of the air switches. Their control is secured by the movement of the controller, which completes the circuits to the various magnet valves on each motor car, which, in turn, secure the operation of corresponding air switches. The various resistance and motor changes are thus simply and positively attained.

The air supply is common to the brake system, and its use is so slight as to be negligible. A separate air reservoir is installed, thus obtaining a continuance of air supply for control operation in case of the failure of the air compressor.

A number of independent or unit switches are grouped together radially about a central air reservoir, and operated by small pneumatic cylinders, the valves of which are controlled by electromagnets. This arrangement makes possible the use of a single magnetic blowout coil for the entire group.

Each switch is enclosed in an insulated box with removable shields. The contacts are of the best copper, large and heavy, and are closed with a rocking and wiping motion, which keeps the surfaces smooth and bright.



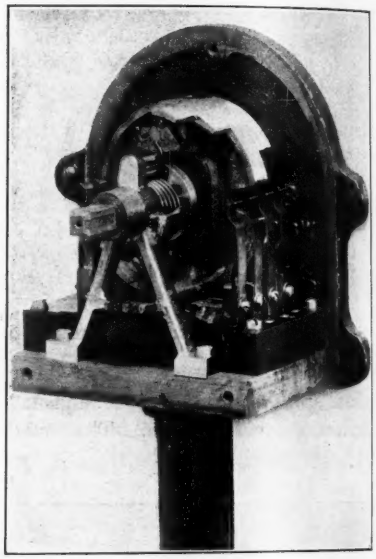
REVERSE SWITCH, COVER REMOVED.

Magnet valves for controlling the several unit switches are so interconnected by small mechanical interlock switches that the closing of one energizes the magnet of the switch next succeeding. The automatic progressive action thus provided is regulated by a "limit switch," so adjusted that the various switches are successively closed, so as to afford an uniform acceleration with a constant motor current.

The rate of acceleration is determined by the adjustment of the "limit switch," and is independent of the personal characteristics of the motorman. The magnet coils and contacts are effectively protected, both as to insulation and mechanical interference. The heavy wiring and connections are enclosed in an insulating box, and the leads are sealed in through outlet boxes. The enclosing cover is divided into two parts, which are swung on a central axis, so that the case may be opened at any point, and easy access obtained to any switch or operating cylinder.

The "limit switch," which determines the motor current during the acceleration, consists of a small switch in the control circuit, governing the progressive movement of the unit switches, and is actuated by an electromagnet in series with the motor circuit, so that the switch is opened and the progressive action of the unit switches arrested whenever the motor current reaches a predetermined amount for which the "limit switch" has been adjusted. As soon as the motor current falls below this amount, the switch closes.

To protect the motors from an abnormal rush of current, in case the main line circuit is suddenly reestablished after interruption, a line relay is introduced in the controlling circuit, and arranged to



CONTROLLER, OPEN.

open the unit switches in case of failure of the line supply. This relay is actuated by an electromagnet connected in shunt across the supply circuit, so that the relay switch is held closed unless the current supply is interrupted.

The construction of the reverse switch is simple and substantial. An insulating block, which carries two sets of metal strips arranged to make contact with stationary fingers, is operated forward and back in a simple straight-line motion by the pistons of two pneumatic cylinders. These cylinders are controlled by electromagnetic valves, which are, in turn, governed by the master controller.

The current which actuates all the electromagnetic valves of the system is supplied by a few small storage battery cells. The potential of this controlling current is fourteen volts.

The low-voltage operating circuits from the storage battery are the only lines which are carried from car to car. Elec-

trical connection between the cables of adjoining cars is established by means of two sockets permanently mounted on the ends of the car, and a pair of plugs which are connected by a short flexible cable. The sockets each contain seven split pins mounted on an insulating base. The plug consists of a malleable-iron shell surrounding a cylindrical piece of insulating material, in which are set seven small brass receptacles which fit the split pins in the main sockets.

The controller is of small size, being only seven and one-half inches high, six inches wide, and four inches deep. It consists of a horizontal shaft supporting a contact and drum, which is rotated in one direction to secure forward movement, and in the opposite direction to secure reverse movement of the train. There are two running positions only in each direction, one which corresponds to full series, the other to full speed. If it is desired to arrest the operation of the car or train on any resistance point, the controller is simply moved off the contact and, by opening the circuit, prevents further advance of the unit switches. The off position is the mid point with the handle vertical. If the motorman removes his hand, the switch drum returns automatically to the off position.

Diverters are built up of grids of cast metal assembled in supporting boxes of convenient size. The usual clamping of the sections is supplemented with a brass connector, thus ensuring permanency of resistance.

"Shawmut" Conduit Outlet Bushing.

The Chase-Shawmut Company, Newburyport, Mass., has placed on the market the "Shawmut" conduit outlet bushing, which is designed with the aim of securing a perfect capping for the free ends of iron-armored conduits. The production of this device is the result of

CONDUIT OUTLET BUSHING.

careful study of all the commercial conditions which it must necessarily meet. The base or threaded portion is octagonal, making it easy to set in place either with a wrench or by hand. The outer portion is perfectly round, forming an even surface for the insulated conductors to ride over, at the same time making a neat appearance.

The bushing is shown in the accompanying illustrations. By reason of its shape, the bushing occupies a minimum amount of room when used on the interior of an outlet box, both as to diameter and

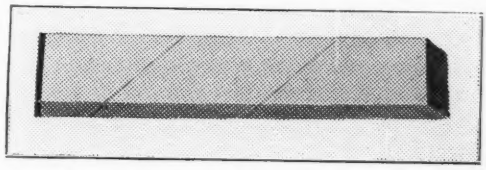
CONDUIT OUTLET BUSHING.

depth; and when used in connection with the company's special check nuts, it forms a compact working arrangement.

The bushings are finished in copper plate to prevent oxidization. Owing to the process of manufacture, these outlet bushings are uniform in size and shape, and, being punched from smooth, clean metal, there are no fins, burrs or rough edges to destroy the purpose for which they are designed.

A New Woven-Wire Dynamo Brush.

The Mullinix Electric Company, Norwood, Cincinnati, Ohio, has brought out a new idea in a woven-wire brush. This brush is made throughout of a special bronze gauze which has been given a heavy copper plating. Brushes made of



WOVEN-WIRE BRUSH.

this material have been found to have great wearing capacity, and, at the same time, have been proven by numerous tests to have greater carrying capacity than ordinary grades of so-called pure copper brushes.

The Safety woven-wire brush, as this type has been designated, has been produced, the manufacturer states, at much less cost than the pure copper brushes. The low cost, prolonged life and decreased friction are said to make it an ideal article. The company willingly sends any number on trial, to be returned at its expense if not as represented. The Mullinix company also manufactures the Safety asbestos lamp shade, Safety lamp guard, Safety soldering paste and Safety commutator dressing.

Storage Batteries for Stationary and Vehicle Work.

The New England Motor Company, Lowell, Mass., is placing on the market a line of storage batteries for stationary and vehicle work which it claims possess a number of features, while not exhibiting any entirely novel construction.

The cells are of the pasted type. The oxides are applied to moulded grids in the usual manner. The negative plates, after being formed, are subjected to considerable pressure so as to consolidate the spongy lead and make it more adhesive. The positive grids are oxidized before being pasted.

In the vehicle-type cells, grooved wooden separators are used. The wood is treated by a special process to prevent the formation of acetic acid or gum dextrin. The details of this process are not given, but it has been the result of considerable experimentation on the part of the company. The company has been building these batteries for some two and one-half years and using them on automobiles and launches, with a view to thoroughly testing their efficiency and capability to withstand hard usage.

While no special effort has been made to obtain large output per pound in the vehicle type cells, the performance is stated to be very creditable. The 150-ampere-hour cell, at the four-hour rate, weighs complete twenty-eight pounds, making a cell of exceptional lightness for the capacity, this giving an output of ten watts at the four-hour rate per pound of complete cell. At the same time, the grids are of such form as to give mechanical rigidity, so that efficiency has not been sacrificed for weight.

Special machinery has been designed for the production of the plates, and prompt shipments can be made in any quantity. Upon application, the company will be pleased to furnish bulletins descriptive of this apparatus.

Electrochemical Exhibits at the World's Fair.

The secretary of the American Electrochemical Society, Mr. S. S. Sadtler, would like to have members who represent companies exhibiting electrochemical and electrometallurgical products or apparatus at the World's Fair, send him full descriptions of exhibits, with locations, giving the building, section and number. It is intended to prepare bulletins, so that members arriving in St. Louis may save time in finding exhibits that especially interest them. Communications should be addressed to the secretary at the Coliseum, St. Louis, Mo.

Western Electric Company Motors and Generators.

The accompanying illustrations show some of the details of a line of motors and generators which the Western Electric Company, Chicago, Ill., has brought out to meet the demands of different industries and classes of service. Fig. 1 shows a semi-encased type "E" machine. The type "D," Fig. 2, or completely encased machine, is furnished with solid covers, and the type "C" machine differs from the type "D" in that cast-iron grids are furnished in place of a solid cover.

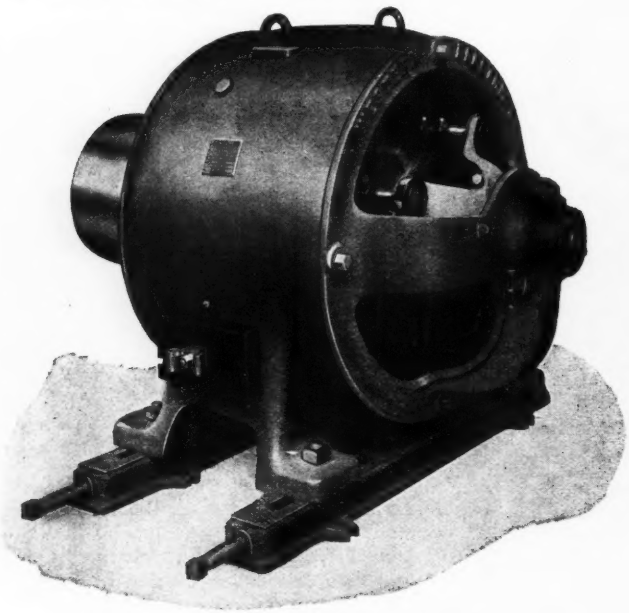


FIG. 1.—SEMI-ENCLOSED, TYPE "E."

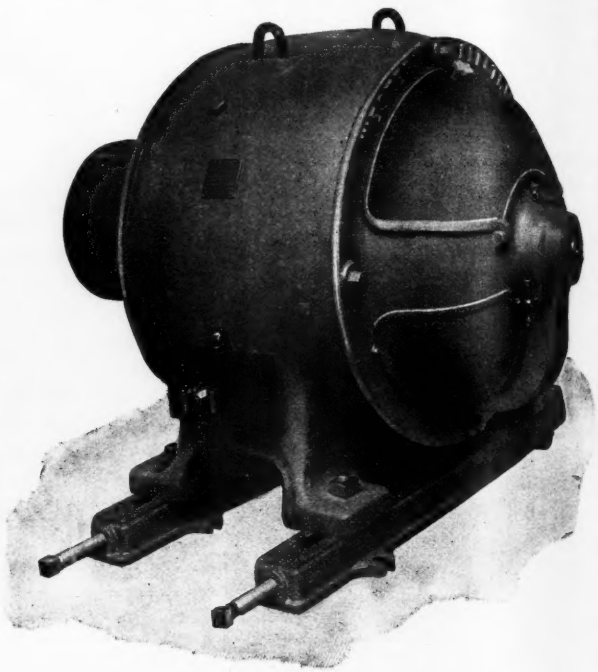


FIG. 2.—ENCLOSED, TYPE "D."

The encased type of machine is especially adapted for use in out of the way places where it will receive but little attention, and where dust, chips and fumes are likely to interfere with the operation of machines of a style not completely protected.

The protected, or type "C" machines, are of the same general design as the encased machines, and are adapted particularly for operation in places comparatively free from dust and fumes. The cast-iron grids used in place of the solid covers are sufficient protection against chips or other large particles, while, at the same time, permitting a limited circulation of air through the windings.

The semi-encased machines are well protected against ordinary mechanical injury, and, at the same time, permit of perfect ventilation of all parts of the machine. The ventilation of the protected and semi-encased types permits running them at higher outputs, and, conversely, a given output at lower first cost than the encased type. The semi-encased machines are rated at slightly higher outputs than the protected type.

The frames of all three types are the same, the difference between the three types being only in the addition or omission of the covers. The poles are of laminated sheet steel, punched to finished dimensions, and assembled on four substantial rods with one-quarter-inch boiler plate at either side, into which the rods are riveted in countersunk holes. The punchings also fit accurately over a large steel bar near the frame end of the pole. This is shown in the accompanying illustration, Fig. 3; a complete set of field coils is shown in Fig. 4. The bolt for holding the pole in place is screwed into this steel bar. This construction forms a rigid pole, which ensures a perfect joint between the pole and frame, without in any way interfering with the advantages of the lamination.

FIG. 3.—FIELD POLE.

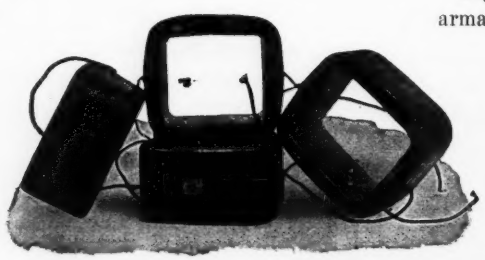


FIG. 4.—COMPLETE SET OF FIELD COILS.

Fig. 5 shows the finished armature. The armature laminations are of the best grade of transformer iron, carefully annealed and japanned. They are mounted directly on the shaft and held in place by end plates. The end plates have flanges for the support of the coils. Large horizontal and radial ventilating spaces are provided. These ventilating spaces are obtained by means of metal spacers. The shafts are of high-grade steel, amply large

FIG. 5.—ARMATURE.

to withstand all stress they may be called upon to carry. The armature coils are form-wound to their finished shape. They are separately insulated and waterproofed before being assembled on the core. After being placed in position, the coils are held by fibre wedges in the core, and by band wires at the ends. The fibre wedges are held by notches in the armature teeth near the periphery.

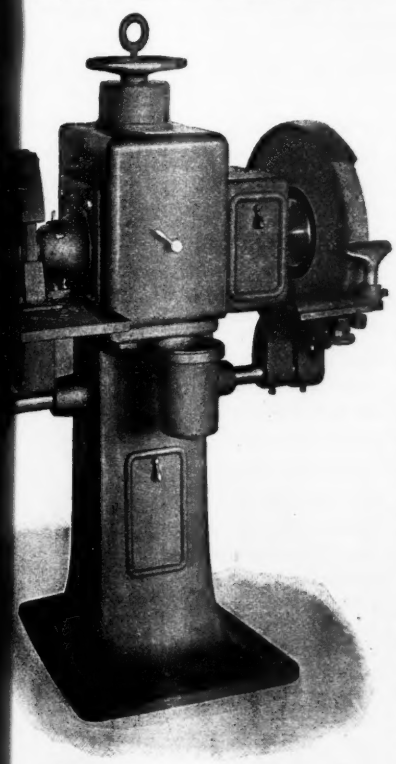
The commutators are of hard-drawn copper, insulated throughout with mica. The mechanical construction is exceptionally substantial. Ventilating spaces are provided near the shaft.

The machines are all made in quantities, each part being standardized and made to gauge to ensure interchangeability.

For the most part, these machines are rated under two different speeds. Armatures may be wound, however, for slower speeds to meet any requirement.

An Electric Emery Grinder.

The electric emery grinder shown in the illustration possesses many points of particular value. This machine might almost be designated as semi-portable, since by loosening a few bolts it can readily be moved from one place to another without regard to line shafts or belts. This advantage is obtained by the use of a direct driving motor.



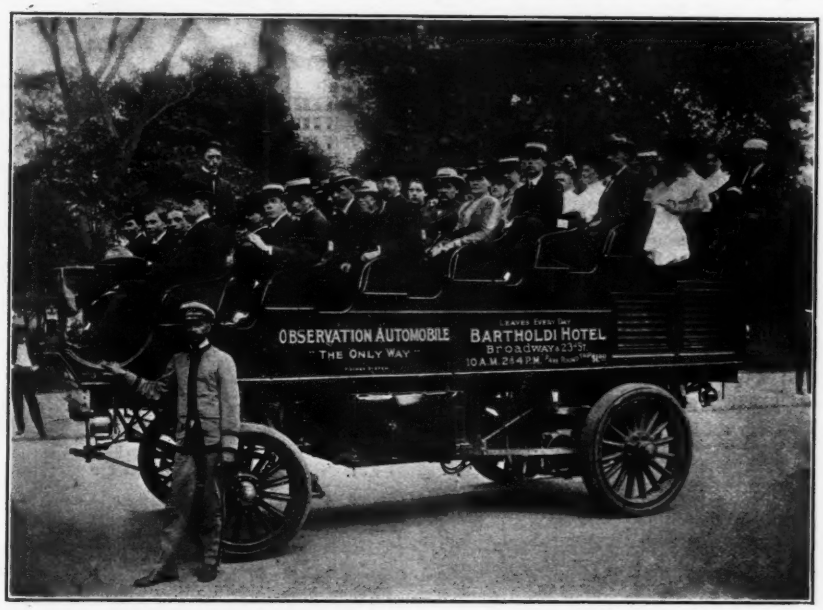
MOTOR-DRIVEN EMERY GRINDER.

It has been the endeavor of the Stow Manufacturing Company in making this grinding machine to produce a grinder as nearly perfect as possible. In this it has realized to the fullest extent its method of motor speed control. As is well known, the Stow method of control gives all speeds between the upper and the lower limits. The speed of the grinder is controlled by the hand-wheel shown on top of the machine, and the slightest turn of this produces a corresponding change in the speed of the motor. In this way the operator is enabled to get exactly the right speed for the size of wheel in use, not one approximately correct.

The tool as illustrated shows two wheels mounted; that on the right being a dry wheel, that on the left a wet wheel. Below the latter is mounted a water tank, and by means of the handle shown the water in this can be raised to any desired height, thus coming in contact with the wheel, wetting the surface uniformly. While the machine is mounted with one wet and one dry wheel, both wheels can be wet or dry as desired. Both are provided with convenient detachable rests for grinding. The wet wheel has a catch-pan into which the spray is thrown and returned to the tank, and there is a cast-iron water-pot conveniently located between the two wheels. The motor is started and stopped by turning the short lever shown on the motor to the right or left. The entire outfit has been carefully designed, the base has been made of use and the running parts are carefully balanced so as to avoid vibration. The machine as shown is adapted to wheels not exceeding twenty-four inches in diameter. The grinder is made by the Stow Manufacturing Company, Binghamton, N. Y.

A Terraced Automobile.

Sight-seeing in large cities has been made comparatively easy by the adaptation of automobiles to this purpose. The automobile shown in the accompanying illustration seems to have particular advantages for this service. It will be noticed that the seats are arranged in a terrace, each rising a little above the one in front, thus differing from the usual practice, which has been to arrange all on the same level. The terrace arrangement gives each passenger an unobstructed view, and adds much to the pleasure and satisfaction of the ride.



A TERRACED "OBSERVATION" AUTOMOBILE.

In this vehicle each seat is terraced five inches above the one just in front of it. The centre of each seat is removable, the last seat excepted, and passengers are allowed to enter from the front of the vehicle, that part which is nearest the ground. There are eight rows of these seats, each seating five passengers comfortably, though, when necessary, six passengers can be accommodated on each, making the total load forty-six, exclusive of the operator. This arrangement of seats also gives the machine a good appearance, and at the same time furnishes ample room for the machinery, which is placed at the rear of the car.

The length of the car is eighteen feet six inches; it is seven feet seven inches wide, with a wheel base of ten feet three inches. The gauge is six feet five inches. The car weighs, when empty, 13,000 pounds, and is geared to a speed of ten miles per hour. The machine is built by the Fischer Motor Vehicle Company, 39 Fourteenth street, Hoboken, N. J.,

and is equipped throughout with the Fischer combination system.

The frame is built of channel steel, the wheels of artillery type with solid rubber tires. The front axle is built up of wrought iron, on the bridge truss principle. The rear axle consists of a diamond-shaped steel frame, supporting two electric motors with the necessary gearing, brake mechanism, etc. The front springs are of the platform type, and the rear springs are half elliptic. The car is steered by a horizontal hand wheel operating through a rack and pinion.

The driving equipment is a four-cylinder gasoline engine, with opposed horizontal cylinders running 550 revolutions per minute. It is lubricated by means of a positive feed mechanical oiler driven by the engine. The crank case of the engine is extended so as to form a subbase for a ten-kilowatt 120-volt shunt-wound dynamo. The engine is regulated by an automatic throttle governor. The battery equipment consists of forty-eight cells, with a capacity of 136 ampere-hours at a three-hour rate. The motors are 7.5 horse-power each, series-wound and will stand an overload of 200 per cent for half an hour, or 100 per cent for one hour. The car is supplied by the Weston voltmeter and ammeter. The gasoline tank has a capacity of twenty-eight gallons, which is sufficient for a run of from 90 to 100 miles.

D'Olier Universal Sockets and Shades.

Among novelties in sockets and shades suitable for incandescent electric lamps is the socket recently brought out by the Henry D'Olier, Jr., Company, Philadelphia, Pa. This device possesses the following points: the diffused light that is thrown from the universal socket and shade can be turned readily in any direction by means of the rotation of the shade

FIG. "A".—UNIVERSAL SOCKET AND SHADE.

around both a vertical and horizontal axis.

Where the device is designed to be suspended on a cord drop it has been ingeniously counterweighted so that it will remain in a horizontal position no matter in what direction the reflector may be turned. The incandescent lamp is so introduced in the fitting that no light can escape except in the direction in which it is to be used. Since the reflector is not ventilated no troublesome patches of light will escape to enter the eye of the worker, or throw unnecessary patches of light on surrounding objects.

FIG. "B".—UNIVERSAL SOCKET AND SHADE.

By reason of the fact that all the light is thrown in the direction desired the candle-power of the light as it is received on the surface of the work is notably higher than in the case of ordinary lighting attachments, which either permit a

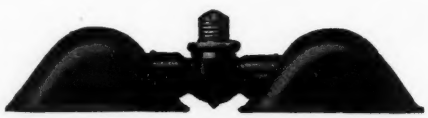


FIG. "C".—UNIVERSAL SOCKET AND SHADE.

large quantity of the light to escape through the bare opening or openings into other parts of the room or through the translucent walls of the shade directly to the eyes of the worker.

By reason of the construction of the socket which enables the lamp to be held in a horizontal position as well as from

FIG. "D".—UNIVERSAL SOCKET AND SHADE.

the nature of the substance with which the surface of the shade is covered, there is ensured a uniform illumination on the work that can not be obtained with other devices.

The accompanying illustrations of the universal sockets and shades show the several styles with key and keyless socket tops for direct connection to cords or fixtures, and also with attachment plug tops for use where sockets are already installed. In the single fixtures the counterweight is shown at the left of the shade. Figs. "B" and "D" illustrate the steel fixture finished in black enamel, while Figs. "A" and "C" illustrate fixtures that may be finished in either "brush" or polished brass or with brass bodies and green shades.

Telephone Development in New York City.

The remarkable development of the New York Telephone Company's system is the best possible proof of the efficiency of the service which that company renders.

It is an exceedingly difficult problem to render an uniformly efficient service in a big city like New York, but, nevertheless, if the service is not uniformly efficient the public will decry it in expressive terms.

Every telephone user is for the time being his own operator, and any weakness in the general system of operation is exposed to his criticism. Moreover, the city user is impatient and demands rapid-fire service.

That he gets this is evidenced by the fact that the average time of answering a call has been reduced to 3.8 seconds, counting from the time the receiver is removed from the hook until Central answers.

The average rate system of charging for this service has also had a great deal to do with the general adoption of the telephone and the spread of the telephone habit.

Under this system the subscriber is charged a minimum rate covering cost of installation, and further than that he simply pays for messages sent. This method of charging brings the service within the means of all, and has aided greatly in the extension in New York City of a great public system for the transmission of speech.

Telephone Cables Injured by Insects.

The Sino-Japonaise Telephone Company, of Shanghai, has made an interesting discovery, which is reported in *La Revue Pratique de l'Electricite.* Some years ago the aerial telephone cables of this company gave a great deal of trouble due to puncturing of the lead sheathing. It was thought at first that the damage was done by mischievous boys, and a reward was offered, in an endeavor to detect the culprits, but without result. A further study of the difficulty then revealed the fact that the holes in the lead, which were small and round, were made by an insect which usually lived upon bamboo. These insects develop in July and August, and finally lay eggs in the openings which they make in the lead cover. No trouble was experienced on those lines which did not pass near bamboo thickets. A simple and effective remedy for the trouble was to wrap the cables with burlap soaked in boiled linseed oil, instead of lead. Since this has been done no trouble has been experienced.

The Electric Storage Battery Company at the World's Fair.

In section 20 of the Palace of Electricity, at the Louisiana Purchase Exposition, is located the exhibit of the Electric Storage Battery Company, of Philadelphia.

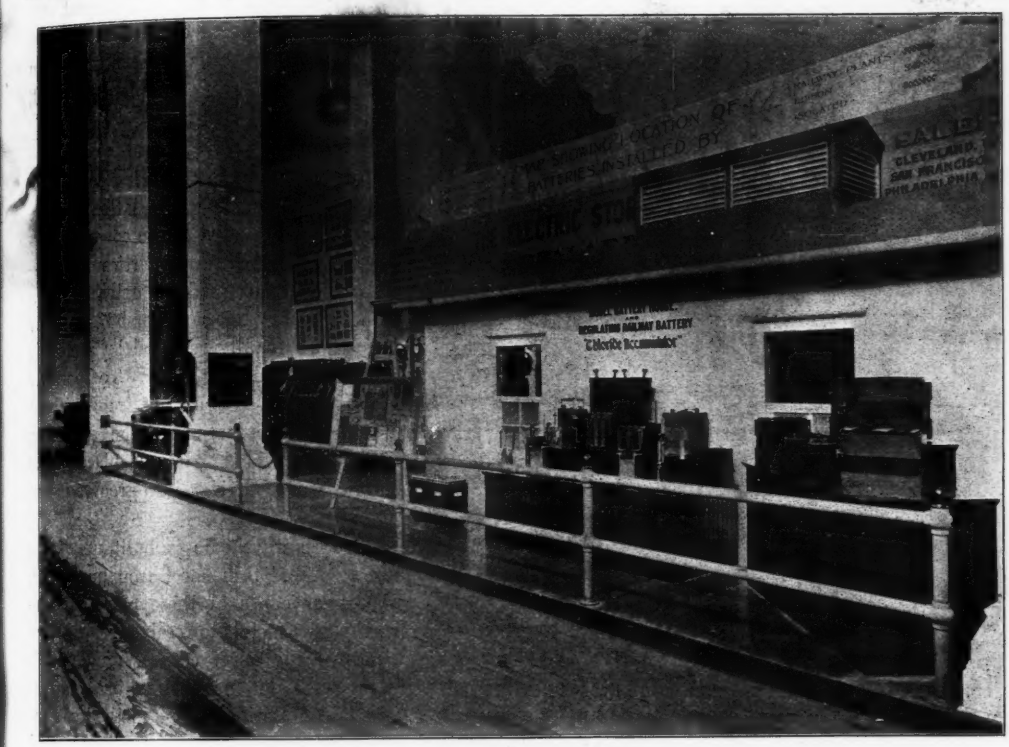


EXHIBIT OF THE ELECTRIC STORAGE BATTERY COMPANY AT THE WORLD'S FAIR, ST. LOUIS, MO.

As this is the largest, most comprehensive and instructive exhibit ever made of storage batteries and apparatus used in connection with battery installation, a visit to this display will be of interest to electrical engineers.

One of the prominent features is a large map of the United States, about thirty by forty-five feet, on which is indicated, by means of colored jewels, the location and character of the various installations of the "chloride accumulator." The exhibit includes a model battery house, in which is installed a model regulating railway battery operating on a variable load. Five standard marble switchboard panels are shown, including the panels for controlling the model railway battery. The other panels are an Edison central station three-wire panel, the panels for regulating combined lighting and power loads, the railway feeder panels and panels for regulating railway power-house loads. Two motor-driven boosters are also shown, the smaller being used in connection with the model battery, and the larger a standard 100-kilowatt railway regulating booster.

Among the types of chloride accumulators are three H-61 cells, with a discharge capacity of 4,800 amperes for one hour, six cells type G-77, capacity 3,000 amperes for one hour, and type G-17 and F-17, all of these being in standard lead-lined wooden tanks.

The smaller cells shown are types "F," "E" and "D" in glass jars, and types "E" and "D" in rubber jars for train lighting and yacht lighting. There is also shown a very complete set of "Exide" cells for automobiles, and "Exide" sparking sets for gas and gasoline engine ignition. The "Exide" exhibit includes a large easel, showing in detail the various component parts of the "Exide" battery.

At one end of the space is a group of three large end cell switches, operating from the Edison three-wire panel. Each of these switches is of 2,000 amperes capacity and is motor driven with electrical indicators. These end cell switches are in actual operation and are so arranged that each switch may be driven by its own motor, or by means of clutches any two or all may be driven by any one motor. Clutches and hand wheels are also provided whereby the motors may be thrown out of gear and the switches operated by hand.

The model battery, with its booster and switchboard, forms a very interesting working exhibit. The battery is of type E-15, in lead-lined wooden tanks, and is mounted on white enamel brick tiers. The battery is in every particular an exact model in miniature of the larger railway installations. The battery is insulated from the brick tiers by means of standard double insulation, consisting of vitrified bricks, then glass insulators, then prepared wood stringers and another set of glass insulators.

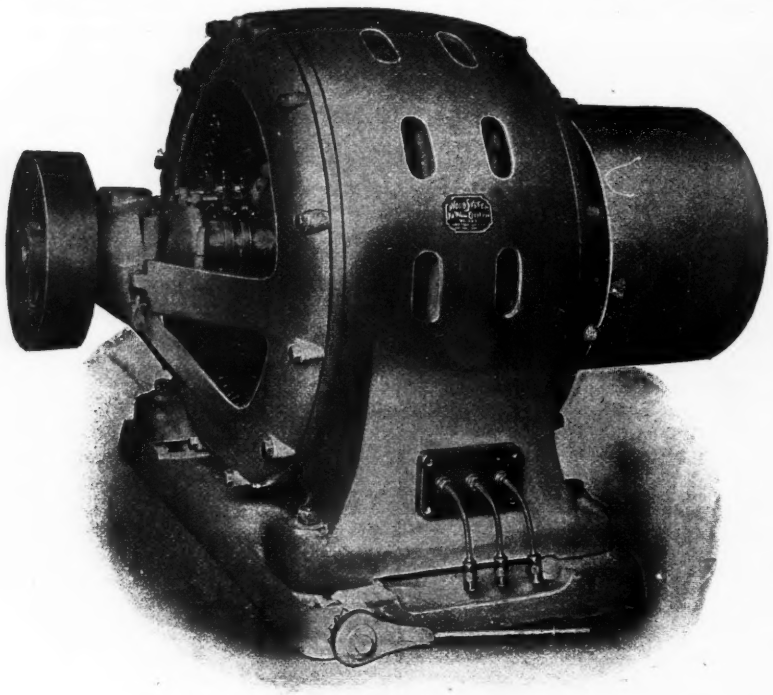
On the switchboard controlling the model battery are the necessary battery and booster switches and automatic circuit-breakers with their interlocking devices, a Bristol recording voltmeter and the Weston instruments, consisting of voltmeter, the zero centre battery ammeter, the generating ammeter and the total load ammeter. The conditions under which the model battery operates are exactly similar to street railway conditions. The generator delivers the average current required and as a heavy external load is thrown on the system the battery assumes the load, the needle of the generator ammeter remaining almost stationary. As the load is thrown off the battery automatically charges. The external load is caused by starting up the 100-kilowatt booster and by throwing on a bank of 80-100 candle-power lamps. As an example of how well the battery regulates the load, it may be stated that the direct-current circuit supplying power to the exhibit is limited to 100 amperes. With the battery regulating, a load of 300 amperes is thrown on the system, causing a drop in the lighting or generator circuit of less than one volt in 110, and a rise in current in the line, or generator circuits, of less than seven and one-half per cent of the total load. The action of the battery is automatically controlled by the small boosters and its carbon regulator.

An Invitation to Visitors to St. Louis.

The Columbia Incandescent Lamp Company, St. Louis, Mo., through its president, Mr. A. C. Garrison, desires to extend to all visitors to that city in connection with the International Electrical Congress, an invitation to call at its offices during their stay. The Columbia company's offices are at 2115 Locust street, seven blocks west of the Coliseum, where the meetings of the congress will be held. All who will give themselves this pleasure will be assured a hearty welcome from President Garrison.

A New Line of Multiphase Alternators.

A new line of multiphase alternators has been recently developed by the Fort Wayne electric Works to complete its line of alternating-current generators. This company's single-phase "Wood" alternators have been well known for years and are in very general use in this country.



THREE-PHASE, REVOLVING FIELD, BELTED, FORT WAYNE GENERATOR, TYPE TRB, 12-200-600, 2,300 VOLTS.

The new line is built for two-phase or three-phase, 1,150 or 2,300-volt systems, and comprises a large number of standard sizes, both belted and engine-driven, varying from thirty-kilowatt to 450-kilowatt.

The revolving-field type of construction adopted in these machines is now generally recognized as most desirable for multiphase generators. By reversing the armature and field from the usual positions found in direct-current and in some alternating-current generators, several important improvements are effected. The armature is stationary and surrounds the field poles which revolve on the shaft within the armature. This relieves the armature conductors of the centrifugal strains to which they are subjected on a revolving armature, and simplifies the question of construction and insulation. The result is the use of form-wound coils laid in rectangular slots and ensures thorough insulation for each coil.

In these generators the fields are mounted on a hub or on a ring carried by arms, on the revolving shaft inside the stationary armature which is mounted in the frame which replaces the field yoke of revolving armature machines.

There are no high-voltage collector rings and no high-voltage conductors in motion. The entire armature winding is solidly bedded in the laminated core held by the frame, so that no motion of high-voltage conductors is possible. The terminals are mounted on marble boards on the side of the frame.

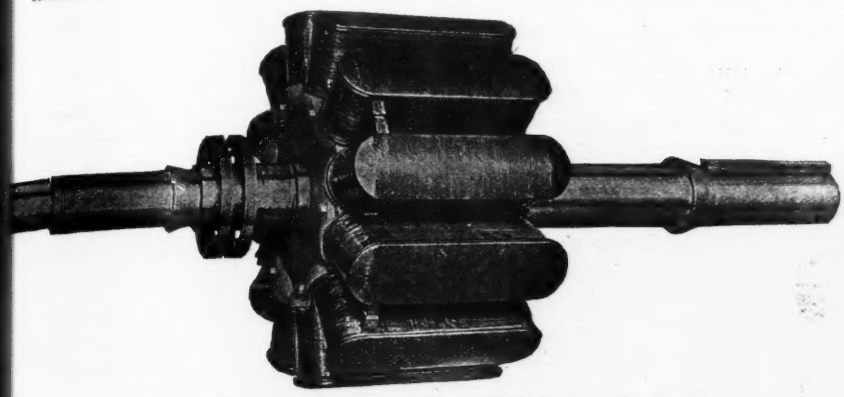
The field exciting current is obtained from a separate generator and carried through brushes and collector rings on the shaft to the field coils. This low-voltage exciting current is the only current carried through moving contacts.

The armature coils are constructed in units, each coil being completely formed, insulated, and tested by itself before it is placed on the core. The coils consist of copper wire or strip according to the size of the machine. The insulation consists of a specially treated fabric covering having high insulating properties and mechanical strength without extreme thickness. In case of accident or burn-out any coil can be readily replaced by removing a few of the adjacent coils. Temporarily a coil can be cut out entirely without affecting the operation of the generator. The coils are held firmly in place in the slots by wedges driven into grooves in the teeth.

The armature core is built up of the best grade of thin sheet iron punchings. The inner edges of these punchings are provided with slots to receive the armature winding; the outer edges with dovetails fitting with slots or mortises in the armature frame casting. This method of construction produces an exceedingly rigid core which can not deviate from a perfect circular form. The laminations are coated with japan and sheets of thin paper are inserted at frequent intervals to prevent

STATIONARY ARMATURE AND FRAME FOR TYPE TRB, BELTED, FORT WAYNE GENERATOR.

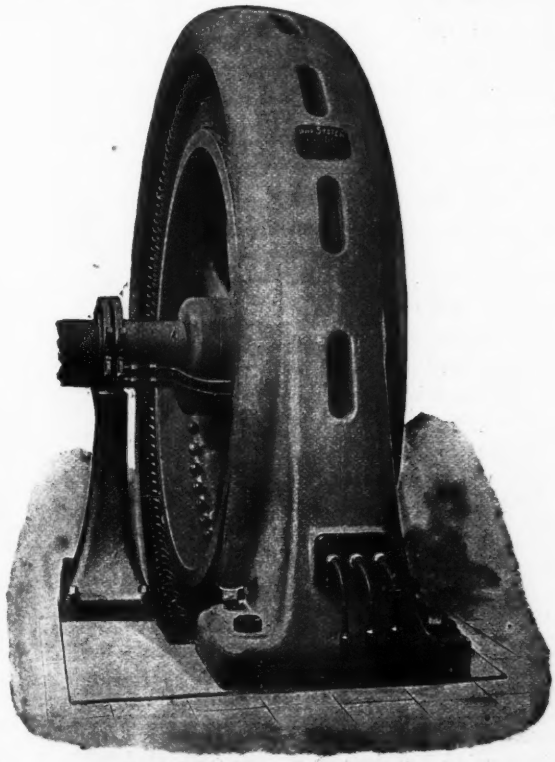
eddy currents. Ventilating ducts pass from the inner surface of the core to recesses in the frame casting, providing a circulation of air across the coils and



REVOLVING FIELD AND SHAFT FOR TYPE TRB, BELTED GENERATOR.

through the core when the machine is in operation.

The field poles of the Fort Wayne revolving field multiphase generators consist of heavy sheet-iron punchings, having projecting pole tips. These punchings



THREE-PHASE, REVOLVING FIELD, ENGINE-DRIVEN, ALTERNATING-CURRENT, FORT WAYNE GENERATOR, TYPE TRE, 48-200-150, 2,300 VOLTS.

are held together by countersunk bolts clamping them between two heavy end plates which form rounded ends for the field coil windings. The projecting tips hold the coil in place and increase the amount of armature surface covered by the field poles. The field coils consist of bare strip copper wound on edge, the successive layers being separated by paper insulating strips.

The field spool consists of an insulating form with end flanges which insulate the winding from the end of the pole pieces and from the field ring.

The pole piece is securely fastened to the field ring by dove-tailing or by bolts passing through the pole pieces, that method being used which is most suitable to the centrifugal strain produced by the speed of rotation.

The field ring or yoke is a casting bolted to a cast-iron spider which is carried on the engine shaft in the engine-driven generators. In the smaller sizes for belt drive the pole pieces are mounted on a solid centre hub instead of on a spider.

The revolving-field type of generator is particularly adapted to engine drive, because of the large flywheel effect of the heavy revolving field, which adds to the inertia of the engine flywheel and maintains a uniform potential on the circuits applied by the generator.

The rigid construction of the revolving elements and the stationary position of the armature winding permits large diameters, and, consequently, slow speed of the shaft, thus adapting these generators especially for direct connection to steam engines of standard slow speed.

The American Engine at the World's Fair.

The American Engine Company, Bound Brook, N. J., is making a very interesting exhibit in block 59, Machinery Hall, World's Fair, St. Louis, Mo. This exhibit comprises features which should interest all who may contemplate the use of direct-coupled units.

A prominent feature is a 125-kilowatt, 110-volt, direct-current generator and duplex compound engine. This latter engine comprises practically all of the advantages of a cross-compound engine, while requiring no more floor space than a single-cylinder machine. By the use of the Ball duplex engine the cost is less, and economy is affected in foundation work, installation and operation. An important advantage lies in the fact that both generator and engine are built in the same shop, and, having been tested together before shipment, the consumer is assured of perfect operation after being installed.

The company is distributing an attractive pamphlet in which a number of testimonials are given, along with a list of prominent users of the American Ball engine.

A New Electric Automobile.

A new electric automobile, recently built by the Electromotion Company, Paris, is quite a departure from the usual form of construction. Instead of using high-speed motors and transmitting the motion through chains or gearing, this new machine has the motors direct-connected to the axles. Motors can be placed either on the front or rear axles. They receive their current directly from the accumulators. It is said that a car so constructed can save twenty to thirty per cent of its capacity, otherwise wasted as lost energy. In a trial this new car worked very satisfactorily at five speeds, varying from four and one-half to nineteen miles an hour. There is no noise and no jar in stopping, starting or changing speeds.

The Jeffrey Direct-Current Generators.

The accompanying illustration shows a representative type of the line of direct-current generators built by the Jeffrey Manufacturing Company, Columbus, Ohio. These generators are designed for general mining and power work. The design follows the dictates of the best modern practice, and the company states that no expense has been spared to make it electrically and mechanically perfect. The journal bearings are of the ring-oiling, self-aligning type, of such proportions as to ensure cool running, and the shaft is of a special grade of hammered steel of great tensile strength and wear-resisting qualities.

JEFFREY DIRECT-CURRENT GENERATOR.

The armature has bar-wound coils without joints, except where connected to the commutator. Both armature and field coils have special provision for ventilation, and the windings and magnetic circuits are proportioned to ensure sparkless commutation and absence of heating under sudden and excessive overloads, which are common to mine power installations.

A Device for the Dispersion of Electrical Charges.

Static electricity generated by friction and compression has been for years the cause of considerable trouble to manufacturers in a number of industries. Paper and textile industries particularly are affected by the phenomenon of frictional electricity, and printers experience a great deal of trouble due to the sticking of the sheets under the influence of the electrical charge.

To mitigate the trouble caused in this manner verious devices have been made use of. Attempts have been made to carry off the charge by passing the fabric over tanks of water or by placing sponges at various intervals in the path it must travel in the course of processing, or by bringing pointed conductors in close proximity to the material.

The Portland Company, Portland, Me., announces, through Mr. W. H. Chapman, its electrical engineer, that it has discovered a simple and effective means for removing these static charges. The system depends upon the principle that a static charge spontaneously selects from a neighboring alternating charge the kind and quantity to exactly neutralize itself. It is stated that in January, 1904, a paper bag manufactory reported its production curtailed thirty-three per cent by static electricity sticking the bags together and making it extremely difficult to straighten them up when taken from the machine. A portable apparatus was taken to this mill and applied to five machines, with the result that the bags come from the machine in an absolutely neutral condition, and slide out into a perfectly square pile. The machines which had previously been limited to 200 bags per minute by the impossibility of keeping them straight, were then speeded up to more than 300 per minute, and no trace of static electricity was discovered.

It is also stated that practical tests were made on the carding machines in a woolen mill, where the roving had been sticking to the rub rolls and to other objects, causing frequent breakage and delay. The application of this principle in its simplest form, it is announced, completely removed the difficulty.

The apparatus used for performing the process in the above and several other applications consists of a special transformer located at any convenient point in the building, and connected by a single wire leading to the place where the material is to be neutralized while passing through the ordinary process of manufacture or handling. Here the leading wire is connected to a fine steel wire located eighteen inches or less from the surface of the material as it is passing through, and this steel wire is usually attached to a wooden bar for protection from mechanical injury. The amount of current passing is said to be harmless to a person coming in contact with the conductor, and perfect neutralization has been secured on paper moving at a velocity of more than 600 feet per minute. The apparatus will be manufactured by the Portland Company.

A Push-Button Pendant Switch.

The Trumbull Electric Manufacturing Company, Plainville, Ct., is calling attention to its new pendant switch, an illustration of which is shown herewith. The switch is neat in appearance, and has only one button to operate it. It is guaranteed to operate successfully at its rated capacity (ten amperes at 125 volts) 10,000 times without injury. Any switch failing to come up to this standard will be replaced free of charge.

PUSH BUTTON PENDANT SWITCH.

The switch is a ten-ampere snap switch of a special design, positive in action and easy to operate. It is made in one size only, as above. The standard finish of this pendant switch is nickel-plated or polished brass.

The company has increased its line of type "A" switches from 300 amperes to 600 amperes, and has also taken up the manufacture of panel and switchboards.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ELECTRIC LINE AT VERA CRUZ—Plans have been made for the establishment of an electric street car system in Vera Cruz, Mexico. It is understood that the construction will be commenced at once. The building of an electric street car system in Vera Cruz has been considered by a number of concerns, but this is the first definite action that has been taken. The system will occupy the streets now used by a mule car company, and the lines will be extended until the system embraces about fifteen miles.

NEW RECORD FOR WIRELESS TELEGRAPH TRANSMISSION—It is announced that wireless messages were sent on September 5 from the tower near the Jerusalem exhibit at the World's Fair, to Springfield, Ill., a distance of 105 miles. Messages of congratulation were exchanged by President D. R. Francis and Governor Richard Yates, Mayor Devereaux, of Springfield, and Mayor Wells, of St. Louis. A number of other messages were transmitted between various officers of the World's Fair Commission and the two states.

WORK BEGUN ON PORTO RICO RAILWAY—The Porto Rico Railway, Light and Power Company, the assignee of the franchise granted to the Vandegrift Construction Company to construct and operate an electric railway between San Juan and Ponce, a distance of seventy miles, has started work grading from Rio Piedras toward Caguas, passing near Truilio Alto. The plans and profiles for the line from San Juan to a point between Caguas and Rio Piedras have been approved by the bureau of public works. Contracts are expected to be placed shortly for rails, etc., to be used in the construction and equipment of the road. The system will entail an expenditure of some $2,000,000.

CHICAGO TRACTION DEAL—It was announced in Chicago last week that New York interests in the Chicago traction companies were making arrangements for financing a combination of surface lines, according to plans outlined several times during the past two years. One of these is to form a syndicate to finance and purchase the city railway and organize a new combined corporation. The syndicate was said to have raised $36,000,000 to purchase the stock of the Chicago City Railway Company at $200 per share. It is thought that while this announcement is premature, the merger of the two properties—The Chicago City Railway and the Union Traction Company—is merely a matter of time.

PORTABLE TELEPHONES FOR STREET RAILWAY SERVICE—A satisfactory run was made on September 4 by officials of the Pittsburg Railways Company, between Pittsburg and Charleroi, testing portable street car telephones on suburban lines. Members of the crew and passengers conversed with people in their homes in Pittsburg from far out in the country. Each car carried a portable telephone in a box, equipped with a long-distance outfit, and a transmitter and a receiver. Along the route there are attached to the poles contrivances by means of which the portable telephones, on being attached, complete a telephone circuit in communication with the office of the Pittsburg Railways Company in Pittsburg.

LARGE ISSUE OF BONDS FOR NEW TROLLEY LINE—An issue of $1,000,000 bonds will be made to pay for the construction of the Willow Grove Electric Railway Company's lines, and these will be guaranteed by the Philadelphia Rapid Transit Company. As the charter of the company building the road was obtained by the Union Traction Company, of Philadelphia, the consent of the stockholders of that corporation to the issue of the bonds will be asked at their next annual meeting, on September 21. The new line will be twelve miles long, and the cost of building it is given at $1,300,000. Of this sum the Philadelphia Rapid Transit Company pays $300,000. The line will start from about Eighteenth street and Germantown avenue, and reach Willow Grove through new territory. A new terminal will be built for the new and for the present line. It is expected that the road will be completed in May, 1905.

A FLOATING EXPOSITION—It is stated that on November 15 a large ocean steamer will sail from Seattle, Wash., carrying an exposition which the merchants of the Orient will be urged to visit when it makes port at the various stopping places. The ship will carry no passengers but exhibitors, and no cargo but exhibits. It will anchor only at ports of commercial importance. No admission will be charged, but, on the contrary, every effort will be made to get as many as possible to come aboard, with preference, of course, for those who have business interests. The exhibit ship will visit Yokohama, Kobe, Nagasaki, Shanghai, Hong Kong, Manila, Singapore, Colombo, Mauritius, Delagoa Bay, Cape Town, Adelaide, Melbourne, Sydney, Honolulu, and, on the return, Santiago, Valparaiso and Callao, South America. At each of these ports it will remain from two to ten days, a total of about six months having been assigned for the voyage. American business men are behind this enterprise, and it is thought that most of these are north Pacific coast exporters, allied with whom is Mr. James J. Hill, president of the Great Northern Railway.

HEARING ON VIRGINIA POWER COMPANY RECEIVERSHIP—The case of the Bowling Green Trust Company, trustee, *vs.* the Virginia Passenger and Power Company, *et al.*, came up before the United States Court at Richmond, Va., on September 1, on a ruling to show cause why the temporary receivers appointed in July should not be made permanent receivers. Louis E. Spencer and Ella K. Perri petitioned the court to take no further action in the matter until the Supreme Court of Virginia should have passed on the appeal taken by the Passenger and Power Company from the decision of the Hustings Court of Petersburg, appointing George Cameron, Jr., a receiver of the same property. They also alleged that the Bowling Green Trust Company was not the legal trustee of the bonds of the Virginia Passenger and Power Company, and that C. A. Northrop, one of the receivers, was not a proper person to act as receiver, because of his relationship to Frank Gould, and because of his official connection with the company. The court continued the case until the first Monday in October. In the meantime, the present receivers are to be continued in office until the further action of the court.

NATIONAL BODIES CONVENING AT ST. LOUIS NEXT WEEK.—The International Electrical Congress and Electricity Day next week have attracted universal attention to the city of St. Louis. This will be a convention week in every sense. The National Electrical Contractors' Association holds forth September 14 to 16; the Northwestern Electrical Association, September 12 to 16; the International Association of Municipal Electricians, September 15; the American Institute of Electrical Engineers, September 14. The American Electrochemical Society and the American Physical Society will hold conventions, and the National Electric Light Association and the Association of Edison Illuminating Companies will send official delegates to the congress. For the convenience of those desiring to attend the opening sessions of the International Electrical Congress, a special convention train of the National Electrical Contractors' Association, of the United States, leaves the Grand Central depot, New York city, at 1 o'clock P. M., to-day, Saturday, September 10. Passengers from New York city, Philadelphia, Baltimore, Washington and points south, will board the train at the Grand Central station, to-day. Passengers from Worcester, Springfield, Pittsfield, Boston and points east, will connect with the convention train at Albany, N. Y., at 4.05 P. M., on September 10, by the train leaving Boston at 10.45 to-day. Those passengers change cars at Albany. Mr. Alex. Henderson, 527 West Thirty-fourth street, New York city, is master of transportation. Mr. Milton C. Roach, the general eastern passenger agent of the New York Central Railroad, 1216 Broadway, New York city, has charge of the distribution of tickets.

ELECTRIC LIGHTING.

GAINESVILLE, GA.—The city is to have fifty new electric lights.

CLIFTON SPRINGS, N. Y.—It has been voted to install an electric light plant.

ALLEGHENY, PA.—The city council has authorized the issuance of $40,000 electric light bonds.

CONCORDIA, KAN.—R. S. McCrary has asked for a franchise for a gas and electric light plant.

MEYERSDALE, PA.—Prominent citizens are planning to install an electric plant at a cost of $25,000.

MIAMI, FLA.—The new electric plant of the Florida East Coast Hotel Company has been placed in operation.

BAINBRIDGE, GA.—The city has voted to issue $20,000 of bonds for the installation of an electric light plant.

CAMDEN, N. J.—An electric light plant will be installed by the city at the pump-house at the Morris station waterworks.

NEW ORLEANS, LA.—The Consumers' Electric Company has prepared plans for the installation of an underground system.

SHENANDOAH, PA.—Plans have been drawn up for the remodeling of the plant of the Citizens' Electric Light Company.

MARION, IND.—The Citizens' Light and Heating Company has been granted a twenty-five years' franchise by the city council.

CARTHAGE, MO.—The Winfield council has awarded contracts for an $89,000 waterworks plant and a $30,000 electric light plant.

WILBURTON, I. T.—Contracts for a $50,000 electric light plant have been signed between the city of Wilburton and James Degnan.

SALT LAKE CITY, UTAH—W. S. McCormick recently bought at public auction the Jordan Narrows power plant, paying $37,500 for it.

WEST POINT, IOWA—At a special election it was decided to install a municipal lighting plant, to cost in the neighborhood of $4,000.

PONTIAC, MICH.—The Standard Lighting Company has been awarded the contract by the city council for lighting the city for ten years.

SPENCER, N. Y.—The Newfield Brick Company is planning to install an extensive electric lighting plant at its works near the Newfield depot.

ST. IGNACE, MICH.—The city has voted to install a $15,000 electric light plant. The streets have been dark since fire destroyed the plant June 27.

CHEHALIS, WASH.—The city electric light plant is to be moved to the Hylak saw mill, six miles east of Chehalis, in order to secure a cheap fuel supply.

BALTIMORE, MD.—Plans are being prepared for a municipal heating, lighting and power plant in the wharf district. The cost is estimated at $150,000.

CROOKESVILLE, TENN.—It is reported that the Gainsboro Telephone Company will install an electric light plant in this town within the next few months.

NEWARK, N. J.—The electric lighting plant for the borough of Sussex has been completed. It is located at Woodburn, and the estimates as to it its cost are $30,000.

STILLWATER, MINN.—The Upper River Power Company has completed a cable across Lake St. Croix, and will transmit electricity to Stillwater for power and lighting purposes.

PROVO, UTAH—The city council has adopted a resolution ratifying the action of the mayor and city recorder in executing a contract with the Telluride Power Company.

ABERDEEN, WASH.—The Aberdeen Electric Light Company has sold its plant and franchise to the Gray's Harbor Electric Company. The purchase price was not made public.

ROCK ISLAND, ILL.—The Geneseo city council has entered into a five-year contract with the Geneseo Electric Light Company for 156 incandescent lamps at $24 per lamp per year.

CODEN, ALA.—F. B. Price, of Glenwood, is interested in a scheme to light Coden and Bayou la Batre. The plant will be erected half way between this place and Bayou la Batre.

DECATUR, ALA.—J. L. Echols and associates are contemplating erecting a $15,000 electric light plant for this city. Heretofore Decatur has been lighted from the plant in New Decatur.

LYONS, N. Y.—The Wayne County Electric Company is about to put in a new head-gate at Slater's dam on Canandaigua outlet, to take the place of the two gates now in commission.

FULTON, N. Y.—The board of public works has closed a contract with the Fulton Light, Heat and Power Company for the lighting of the city at $75 per light for a term of ten years.

GOSHEN, N. Y.—It is expected that the new plant for the Newton Gas and Electric Light Company will be in operation by October 1. It is expected that about 500 horse-power will be developed.

ASHEVILLE, N. C.—The Asheville Tannery will shortly place in operation an electric light plant capable of furnishing 300 lights, which will be used to light the tannery grounds and buildings.

BUCYRUS, OHIO—The Bucyrus Gas and Electric Light Company has been sold to James Finley, of Pontiac, Mich., Mr. Finley taking charge August 1. It is understood the price paid was close to $100,000.

LOS ANGELES, CAL.—The Kern River Power Company has awarded the contract for cement lining the company's flumeway in Kern County for a distance of twelve miles. The work calls for an expenditure of $280,000.

DANVILLE, ILL.—The Homer electric light plant has been purchased from G. C. Bowen by U. S. Thompson, of Fithian, who has just completed plans for installing a new plant at Fairmount. The plant is to be remodeled.

BOONE, IOWA—At a recent election the proposition for municipal ownership of the electric light plant was defeated by a vote of 827 to 561. A like proposition was defeated five years ago by a vote of about two to one.

KINGSTON, ONTARIO—The plant of the Kingston Light, Heat and Power Company has been taken over by the city. The city agrees to continue to supply power to the street railway company at $2 per car per day for six months.

ST. PAUL, MINN.—A franchise ordinance granting the St. Paul gas company the right to erect poles and string electric light wires in most of the alleys and on some of the streets in Merriam park has been passed by the board of aldermen.

PITTSBURG, PA.—Sealed proposals for building a power-house at dam No. 2, Ohio river, will be received at the United States Engineer's office, Pittsburg, until 12 M., September 2, 1904. Information will be furnished on application.

JOHNSTOWN, N. Y.—The high-tension wire of the Herkimer County Light and Power Company, which is to furnish light for the village of Mohawk, is to run along the towpath from Little Falls to that village. The work has been commenced.

OSHKOSH, WIS.—W. H. Whitney, of Boston, has purchased the property of the Oshkosh (Wis.) Electric Light and Power Company, which has been for the past eighteen months in the hands of a receiver. The price paid was $215,000.

BLAINE, ME.—An electric light and water company has been organized to be known as the Mars Hill & Blaine Electric Light and Water Company. A. O. Nutter has been elected president; Eugene Smith, secretary, and G. W. Young, treasurer.

HARTFORD, CT.—The borough of Groton has voted to purchase the local electric light plant for $20,000 and the waterworks for $105,000. A mortgage of $75,000 on the properties is included. A total of $150,000 of four per cent bonds will be issued.

BIRMINGHAM, ALA.—The Cherokee Company, which is planning to furnish Birmingham with 25,000 horse-power by bringing it here from the Tallapoosa river at Cherokee Bluff, has increased its

capital stock to $100,000. It is claimed that eastern capital has become interested, and that locks and dams will be built at Cherokee Bluff to concentrate the power. The distance to Birmingham is eighty-five miles.

SCOTLAND, S. D.—At a meeting of the city council A. E. Parmenter was granted a twenty-year franchise for the construction and operation of either an electric light or gas lighting system. Mr. Parmenter will at once commence the work of installation.

LAFAYETTE, LA.—The city council has contracted with the Standard Electric Company, of New Orleans, for two new dynamos and one 250-horse-power engine. The electric plant has been giving unsatisfactory service lately, several breakdowns having occurred.

NORRISTOWN, PA.—An electric light plant is being installed at Bucknell University. The work of wiring is well advanced and is being finished as rapidly as possible. It is expected that the plant will be ready for use at the opening of the fall session, September 22.

NORTH ADAMS, MASS.—Options have been obtained on properties along the east branch of the Housatonic river in the vicinity of the Berkshire street railway power station in Pittsfield by the capitalists who are promoting the new half-million power proposition in Pittsfield.

WASHINGTON, D. C.—Bids will be opened at the treasury department on August 23 for installing a complete system of electric lighting at the United States Courthouse and post-office building at Trenton, N. J. Specifications can be obtained on application to the supervising architect.

READING, PA.—The Sinking Springs Electric Light, Power and Heat Company, at Sinking Springs, this county, has been granted a charter and expects to furnish light about October 1. The officers are: president, William F. Krick; vice-president, Thomas H. Krick, and treasurer, Henry H. Yost.

CHARLOTTE, N. C.—At a meeting of the board of directors of the Catawba Power Company, it was decided to increase the capital stock of the company $100,000, making the total capital stock $850,000. The company has almost completed the work on its transmission line to this city.

WALLA WALLA, WASH.—An electrical plant to cost about $250,000, which will be ready for operation January 1, is being constructed on the Walla Walla river about ten miles from here. The Washington & Oregon Power Company, composed of eastern capitalists, is back of the proposition.

ANNISTON, ALA.—A plant to supply electrical energy to the Anniston, Gadsden & Birmingham Railroad will be erected at lock No. 3 on the Coosa river. The plant will cost $300,000. The idea of the promoters is to erect a large cotton factory, as well as to connect the towns mentioned by a trolley system later.

MOUNDSVILLE, W. VA.—The directors of the Moundsville Electrical Company have let the contract for the building of its new plant. The contract for the equipment has not been let, but will be in a short time, and the machinery will be ready to install by the time the building is completed. The new plant will be 60 by 115 feet.

NEW BEDFORD, MASS.—At the annual meeting of the New Bedford Gas and Edison Light Company the following directors were elected: Horace G. Howland, Thomas H. Knowles, Charles R. Price, George R. Stetson, Charles H. Lawton, Frederic Taber, Oliver Prescott, Jr., John S. Perry, Henry M. Knowles, Lot B. Bates and Parkman M. Lund.

CINCINNATI, OHIO—The waterworks and electric light plant at Harrison, Ohio-Indiana, have been purchased for Cincinnati and Cleveland capitalists by J. P. Hornaday & Company, of Cincinnati, Ohio. The Harrison water and electric light plant completely controls all the public utilities of Harrison, both on the Indiana and Ohio sides of the line.

McKENZIE, TENN.—The stockholders of the McKenzie Electric Light and Waterworks Company have organized with W. F. Scates, chairman, and J. L. Baker, secretary. The following were elected charter members: W. F. Scates, H. R. Larde, Morgan Green, R. B. Moore and C. M. Wrinkle. The charter will be secured at once and work will commence on the waterworks plant.

ITHACA, N. Y.—The Scranton Firebrick Company is planning to install an extensive lighting plant at its works in Newfield. The company intends to have the plant furnish light for the entire works, including several cottages of employés in vicinity of the industrial buildings. It is understood that the work will be commenced as soon as other proposed improvements can be completed.

BOSTON, MASS.—The gas commissioners have authorized the Edison company, of Brockton, to purchase the Whitman Light and Power Company. For the purpose of purchasing the Whitman plant the commission has authorized the Edison company to issue 500 shares of stock at par; the commission has also authorized the issue of 500 additional shares of Edison stock at par to fund that company's floating debt occasioned by addition to plant.

RICHMOND, VA.—Plans are being prepared for the heating, lighting and power plant to be built for the state buildings. It is expected that bids for the work will be asked at the next meeting of the capitol commission. The work can not be done this year in time for the approaching winter, but will be completed before the necessity arises for heat or light in the capitol building in 1905. An appropriation of $25,000 was made for this plant.

HELENA, MONT.—The Gallatin Power Company has been incorporated by E. W. King, C. S. Hartman, S. A. Mendenhall, George Cox and E. J. Carter, all of Bozeman. The company has a capital of $150,000, which has been subscribed. The incorporators also constitute the board of directors. The company is formed for the purpose of establishing a power plant at Sheep Rock, on the West Gallatin river, to generate electricity for various purposes.

WALLA WALLA, WASH.—An electric plant to cost not less than $250,000, and to be ready for operation by January 1 is being constructed on the Walla Walla river, about ten miles from this city. The Washington & Oregon Power Company, composed of eastern capitalists, is back of the proposition, and valuable water rights have been secured. The company purposes to furnish power for the plant in this city, Pendleton, Athena, Milton, Weston and other towns.

BALTIMORE, MD.—S. B. Medairy and R. B. Fentress have been granted a franchise to establish an electric lighting, heating and power business in this city. The grantees are empowered to turn over their franchise to the Baltimore Refrigerator and Heating Company, which may operate it in conjunction with its hot and cold air business. The object of the grantees is to furnish light and power to those who do not desire to put in machinery for the purpose.

GLASTONBURY, CT.—The Glastonbury Power Company has received from its engineer the completed plans of the hydro-electric plant which the company proposes to build on Roaring brook in South Glastonbury. The plans call for 1,600 horse-power in wheels and 1,000 kilowatts in electric units. There will be two large dams, a 500-foot penstock, a 2,500-foot tailrace, a steel and concrete power-house, with a ten-ton traveling crane and an auxiliary gas plant. The contract will shortly be awarded.

NORFOLK, VA.—The merchants of Norfolk are said to be backing a new company which will, in the near future, ask the councils for a franchise. The promoters say they feel confident that they will secure their franchise, which, under the new constitution, must be put at public auction. The company, which is now being organized, will be known as the People's Light, Heat and Power Company. It will have a capital of $100,000, and if the franchise is granted it is probable that many merchants in the city will use the light, which, it is claimed, will be furnished at a reduced rate.

CONCORD, N. H.—At the annual meeting of the Claremont Railway and Lighting Company these officers were elected: Hira R. Beckwith, president; John T. Emerson, vice-president; L. N. Wheelock, treasurer and general manager; E. B. Heywood, clerk; O. B. Rand, auditor; H. R. Beckwith, J. T. Emerson, L. N. Wheelock, O. B. Rand, Ira F. Chandler, F. H. Foster, M. F. Dickinson, Boston, directors. The gross earnings from all sources from August 16, 1903, when the railway went into operation, and November 1, 1903, when the lighting branch was started, to July 1, 1904, amount to $33,159.07, while there remains above all operating expenses more than $7,000.

LEGAL NOTES.

POOL-ROOM TELEPHONE SERVICE—In the supreme court of New York Judge Scott has refused to grant a mandatory injunction restraining the New York Telephone Company from interfering with the telephone service which it had contracted to furnish to the New York & New Jersey Distributing Company. He suggested that if any contract to furnish the service had been violated the remedy was an action for damages, and further, if the company believes its property is being used for unlawful and immoral purposes a telephone company has the right to refuse to live up to its contracts.

NON-STOP LIABILITY—In the case of the Southern Railway Compnay *vs.* Bandy, the supreme court of Georgia held that where a carrier accepts fare for a particular station, it is not sufficient that the speed of the train be slackened, but the carrier is bound to come to a complete stop and afford the passenger an opportunity to safely alight; that a passenger can not rely on the conductor's instructions as sufficient justification for doing an act obviously dangerous; that it is not a want of ordinary care if the passenger uses the means which the carrier affords him for disembarking and that if under the direction of the conductor, the passenger dismounts from a slowly moving train, the company is liable for any consequent injuries.

INTERPRETATION OF "PARTY LINES"—The question "What is a party line?" has been brought up in the Ohio courts by the filing of a request by the Cuyahoga Telephone Company for a judicial interpretation of its agreement with the Dime Savings and Banking Company. The case grows out of a bond transaction in which the bank gave the company a trust deed and acted as trustee. It was provided that sums of money were to be paid over as the construction advanced. The bank claims that desk telephone and party lines were to count as single connections when showing the growth of the company. The Cuyahoga company claims that the connections disputed are of such a nature as to fall within their definition of separate connections.

LIABILITY FOR INJURY TO LINEMAN—In the case of the Cumberland Telephone and Telegraph Company *vs.* Bills, the court decided in the action of the lineman against the employing company for an injury received by the breaking and falling of a decayed pole on which he was placing a cross line, that the company was liable to the plaintiff for his injuries. The evidence showed that the plaintiff had worked at such employment for less than a year and only in the service of the defendant; that the line on which he was working was an old one and that he had not been warned of the danger or instructed to inspect the poles before climbing, and, though he was preceded by the foreman and another whose duty it was, under the rules of the company, to make the inspection, they did not do so. The court further held that a positive duty rested on the defendant company both to warn the lineman and to require an inspection. The foreman was held to be not a fellow-servant of the lineman in regard to the inspection, but a vice-principal, representing the company. The company could not escape the obligation by delegating the duty to the foreman or anyone else.

STREET RAILWAY POSSESSION OF A STREET—In the case of the Newport News & Old Point Railway and Electric Company, the supreme court of Virginia held that if a street railway company having secured a first grant actually occupies a street it is authorized to use, there is reason for affirming that its right to the part of the street actually occupied and used is permanent and exclusive, and that by actually taking possession of the street and using it for the accommodation of the public, the company first in point of time does such acts as vest its rights; but in order to have this effect, the company must take possession in good faith for the purpose of constructing and operating such a railway as its franchise describes, and that a possession taken solely for the purpose of keeping out opposition, and unaccompanied by evidences of intent to furnish reasonable accommodations for the public, ought not to be regarded as sufficient to vest a right under a general ordinance. The court held further, that a forfeiture of a company's franchise by the state owning this property does not confer any new right upon the company, and that advantages can not be taken of it by any competitor in a private action; but that it can only be enforced on behalf of the public at the election of the state.

TELEGRAPH RIGHT OF WAY—In the case of the Atlantic Coast Line Railroad Company *vs.* the Postal Telegraph-Cable company, the court held that a telegraph company acquires an easement in the right of way of the railroad company condemned for the purpose of constructing and operating a telegraph line thereon; that the easement thus acquired embraces the land actually occupied by the poles and fixtures, and the right to stretch wires upon the poles, and to enter upon the right of way to construct and repair the line; that the only exclusive right of occupancy a telegraph company acquires by condemnation is that of the land occupied by the poles for telegraph purposes; that the measure of damages in such cases is the value of the land actually taken and the extent to which the use of the right of way of the railroad company is diminished by its use by the telegraph company; that the right of way of the railroad company has no general market value for other uses; that the appropriation to public use amounts to withdrawal of the right of way to any use, except that which is necessary or auxiliary to the operations of the railroad; that advantages and benefits accruing to the telegraph company from its use of the railroad's right of way can not be considered in assessment of damages, and that remote or speculative damages can not be recovered. The court further held that the suggestion that, at some time in the future, the railroad company might lay additional tracks or build structures for railroad purposes is too remote to authorize the admission of evidence for damages that might result in any such contingency.

PERSONAL MENTION.

MR. F. C. RANDALL, president of the National Electric Company, of Milwaukee, Wis., is spending a few weeks with his family in the East.

PROFESSOR OSBORNE, of Columbia University, received the honorary degree of Doctor of Science at Cambridge University, England, on August 22.

MR. WILLIAM G. NORMAN has been elected manager of the Dubuque Telephone Company. Mr. Victor Stevens, whom he succeeds, continues as president of the company.

MR. GEORGE C. CHADWICK, until recently connected with the United Railways, has been appointed chief engineer of the Santa Cruz, Cal., electric railway system.

MR. AUGUSTUS BRANDEGEE, a former congressman from New London, Ct., has been elected president of the New London Gas and Electric Company, to succeed the late Robert Coit.

MR. C. C. MAJOR has accepted the chair of mechanical engineering at the University of Oklahoma, and resigned his position with the New Century Correspondence Schools, Wilkesbarre, Pa.

MR. H. L. SHIPPY, treasurer of the John A. Roebling's Sons Company, of New York, returned from Europe last week on the Campania. He spent several weeks abroad and returned much improved in health.

MR. PATRICK GALVAN has been appointed chief assistant engineer of the Panama Canal Commission, and will sail for Panama at once. Mr. Galvan was formerly connected with the engineering corps of the Illinois Central Railway.

MR. ISAAC A. SMITH, chief engineer of the Southern Illinois Electric Railway Company, has been made general manager of the road. The capital stock of the company at a recent meeting was increased from $2,000,000 to $2,500,000.

MR. R. E. WILLARD, who has since January last been manager of the Neosho Electric Light Company, Neosho, Mo., has resigned, and in a short time will leave the city to accept a position as manager of a new street railway system in north Missouri.

MR. A. G. BANHAM, of King City, Mo., has been elected president of the St. Joseph, Stanberry & Northern Railway, in place of Mr. George C. Sims, resigned. Mr. A. C. Frisbie and Mr. T. D. Hussey, of Stanberry, have been added to the board of directors.

MR. EDWARD E. GOUDEY, who recently resigned from the management of the Goudey-McLean Company to take a partnership interest in the engineering firm of B. F. Bell & Company, is one of the inaugurators of the Bell Engineering and Construction

Company, which company was organized to succeed B. F. Bell & Company in the business of consulting and contracting engineers. Mr. Goudey is also president of the Bell Engineering and Construction Company.

COMMANDER JAMES H. PERRY, U. S. N., of the Bureau of Steam Engineering, was retired from active service at the age limit, on August 31, with the rank of captain. Captain Perry is suffering at present from an attack of typhoid fever at Washington, D. C.

MR. S. S. NEFF has been appointed general superintendent of the Mexican Tramways Company, Ltd., of the city of Mexico. Mr. Neff has been superintendent of the Boston Elevated Railroad Company, Boston, Mass., and previously superintendent of the Union Elevated Railway, Chicago, Ill.

MR. J. H. NIBBELINK, chief electrical engineer of the Nordburg Manufacturing Company, met with a severe accident at Milwaukee, Wis., recently. While descending a steep hill in an automobile, the machine got away from him. He was thrown into a creek and pinioned down by the machine falling on top of him. He was rescued, however, only slightly injured.

MR. JOHN BLAIR MACAFEE, a contractor and street railway manager and a graduate of the University of Pennsylvania, has been elected president of the Augusta-Aiken Railway Company, of Augusta, Ga. This company controls several railway companies as well as the North Augusta Land Company and Hotel company. Mr. MacAfee was an organizer and at one time vice-president of the Railways Company General and the American Engineering Company.

MR. CYRUS O. BAKER, JR., the well-known platinum refiner, returned last Saturday on the steamer Campania from London. Mr. and Mrs. Baker have been making a four months' trip through Great Britain and the Continent. The itinerary took in Paris, Geneva, Lucerne, Venice, Vienna, Dresden, Berlin, Norway, Spitzenberger, Holland, and a considerable time was spent in traveling through the picturesque regions of Scotland. Mr. Baker combined business with pleasure, and returned home ready to engage in a largely increased production of refined metals.

MR. ROBERT DONALD, editor-in-chief of the *London Daily Chronicle*, was the guest of honor at a luncheon given on Tuesday, August 30, in the rooms of the Transportation Club, Forty-second street and Madison avenue, New York city, by Mr. George H. Daniels, general passenger agent of the New York Central & Hudson River Railroad. Among those present were Mr. Melville E. Stone, general manager of Associated Press; A. J. Campion, Cosmos Mindeleff, E. P. Call, H. L. Bridgman, Ray Morris, Charles W. Price, I. A. McCormack, manager Grand Central station; J. F. Fairlam, auditor passenger accounts; M. L. Bacon, auditor; W. J. Wilgus, fifth vice-president; F. L. Pomeroy, freight traffic manager; W. T. McCulloch, auditor freight accounts; J. E. Root, advertising manager; F. J. Wolfe, assistant general passenger agent; E. B. Katte, electrical engineer; J. K. LeBaron, editor *Four-Track News*. The luncheon was enlivened by a number of toasts, and the guests of honor laid emphasis on the apparent harmony which existed between the railroad management and the newspaper interests of the country. This condition, he said, was in no way approached in the land that he came from. He intended to remain here for some time, studying the transportation problems, as well as studying the American newspaper and the methods employed in bringing it to its present-day success.

ELECTRICAL SECURITIES.

Although with the near approach of the time of general harvesting of crops there is a possibility of a disappointment with regard to a record yield, the market has been maintained with a firmness which appears to be more than professional and manipulative. It is assured that, whatever the harvest outlook may be, there will be good prices all around, and a consequent opportunity for investment which will do much to encourage larger industrial operations. While commission houses generally are still commenting on the lack of interest shown by the public as an investor, there has been a steady improvement for several months, and if the present tendency continues, and is further supported by an influx of money from the rural districts, there is every reason to believe that an animated season will soon be in prospect. It will need very little stimulation for the public—which is at all times ready to take a long chance—to get over its fears of sustaining the same losses as it did about eighteen months ago.

At the present time there exists a condition of importance to the electrical interests of the country. This concerns the record high prices for copper, along with a record demand for this material. The electrification of a number of large steam roads, and the probability of many other changes as soon as the pioneers shall have been shown to be commercially successful, will mean a decided boom in the demand for not only copper, but the engineering appliances and auxiliaries which go to make up transmission and transportation systems.

ELECTRICAL SECURITIES FOR THE WEEK ENDING SEPTEMBER 3.

New York:	*Closing.*
Brooklyn Rapid Transit	55⅝
Consolidated Gas	196
General Electric	169
Interborough Rapid Transit	143½
Kings County Electric	210
Manhattan Elevated	154⅞
Metropolitan Street Railway	121½
New York & New Jersey Telephone	152
Westinghouse Manufacturing Company	162

The Brooklyn Rapid Transit Company has made application to the New York Stock Exchange to list $5,000,000 first mortgage refunding four per cent bonds of 2002. These bonds are the second block of $5,000,000 of the $150,000,000 authorized issue sold to provide for betterments.

The New York City Railway Company has issued its annual report for the year ended June 30, 1904. The income account shows as follows: gross, $21,485,006; operating expenses, $12,127,856; net, $9,357,150; other income, $408,998, making a total of $9,766,148; taxes, rentals, interest, etc., $11,162,919, leaving a deficit of $1,396,771. The balance sheet as of June 30, 1904, shows assets of $187,612,568, and liabilities of $184,645,621, leaving a surplus of $2,966,947. The total number of passengers carried was 630,070,850, an increase of nearly 8,000,000 over last year. Of these, 72,194,495 were carried in the Bronx; 197,595,680 were transfer passengers. The company owns 492 miles of track.

Boston:	*Closing.*
American Telephone and Telegraph	137
Edison Electric Illuminating	258
Massachusetts Electric	60
New England Telephone	125¾
Western Telephone and Telegraph preferred	91

Philadelphia:	*Closing.*
Electric Company of America	9¼
Electric Storage Battery common	62½
Electric Storage Battery preferred	62½
Philadelphia Electric	6⅝
Union Traction	55⅝
United Gas Improvement	89

Chicago:	*Closing.*
Chicago Telephone	122
Chicago Edison Light	146
Metropolitan Elevated preferred	58½
National Carbon common	39
National Carbon preferred	112
Union Traction common	7
Union Traction preferred	35

The August daily average of Northwestern Elevated passengers was 62,453, an increase of 2,360.

The Metropolitan daily average for August was 103,500, an increase of 548 over the preceding month.

South Side Elevated for August showed a daily average of 70,445 passengers carried, a decrease of 2,201, due to business dulness.

Chicago City Railway directors have declared the regular quarterly dividend of 2¼ per cent, payable September 30. Books close September 12 and reopen September 18.

The Illinois Trust and Savings Bank has sent out a circular to stockholders of the South Side Elevated Railroad offering $3,000,000 of South Side Elevated bonds for subscription within thirty days.

ELECTRIC RAILWAYS.

CHANUTE, KAS.—The city council has granted a street railway franchise to F. V. Crouch, of Iola.

RENO, NEV.—The government has planned the construction of an electric road through Churchill County.

GEORGETOWN, DEL.—Arrangements are being perfected ensuring a trolley road for Salisbury, with an extension to Quantico.

LINCOLN, NEB.—Farmers of the South Loup valley are said to want an electric line and to be willing to aid the project in every possible way.

GOSHEN, IND.—Work will begin immediately on the Warsaw & Goshen electric line. The road has been voted a $25,000 subsidy by the city of Warsaw.

LITTLE ROCK, ARK.—There is a project on foot to build a connecting line from the White River road at Oregon Flat to Jasper by the way of Bellefonte.

ROANOKE, ILL.—The council has granted a franchise for an electric line to pass through Roanoke from Peoria to Streator, touching Morton, Eureka, Minonk and Wenona.

DAVENPORT, IOWA—The Davenport & Suburban has been granted a franchise allowing it to build a single track along the Schmidt road from Rockingham road to Grand Isle.

CHICAGO, ILL.—Judge Tuley has authorized Edward F. Bryant, receiver of the Chicago General Railway Company, to spend $83,000 to improve the system under his control.

LANSING, MICH.—The Grand Rapids & Chicago Railway Company has changed its name to Grand Rapids & Kalamazoo Valley Railway, intending to make Kalamazoo a terminal.

PAYSON, UTAH—At a special meeting of the city council B. Mahler was granted a franchise to run his electric railway through this city, the line to be completed within three years.

READING, PA.—A new trolley project is being promoted by several business men. The road is to start at Boyertown and make a loop, taking in Gilbertsville, Swamp, Pottstown, Half-way House and Little Oley.

LARAMIE, WYO.—H. D. McCutcheon and J. D. Boyle, of Pittsburg, have been granted a thirty-year franchise for an electric railway system in this city and given a ten-year contract to light streets and municipal buildings.

LANCASTER, OHIO—The contract has been let for the construction of that part of the Southeastern Ohio Traction line between Zanesville and Crooksville, fifteen miles. Work will commence at once and is to be finished by February 1.

DECATUR, ALA.—A movement is on foot looking to the early construction of an electric street railway from this city to Trinity mountain, a distance of about seven miles. An effort will be made to have the line constructed this fall and winter.

GREENVILLE, S. C.—The counsel for the Greenville & Knoxville Railway states that the rights of way which the company had heretofore been unable to purchase have been obtained, and that everything is in readiness for the construction of the road.

KITTANNING, PA.—Work on the new trolley line between Leechburg and Apollo is to start at once. Officers have been at Leechburg, and it is expected that cars will be running to Apollo by the first of the year. The line will follow the old towpath.

BATON ROUGE, LA.—An interurban electric railway between Baton Rouge and New Orleans has been projected. The estimated cost of the road and necessary equipment is said to be $2,500,000, all of which is reported to have been subscribed by Eastern capitalists.

EGG HARBOR, N. J.—J. H. Bozarth, of Ellwood, has been granted a street railway franchise by the city council. The plan is to operate the trolley through the streets of Egg Harbor, thence to Gloucester Lake, Port Republic, Smithville, Oceanville and Absecon.

LOVELAND, COL.—At a meeting of the board of trustees an ordinance was passed granting a franchise to the Northern Colorado Electric Railway Company. The proposed road is to run through Eaton, Windsor, Fort Collins, Loveland, Berthoud, Longmont and Boulder to Denver.

ELKHART, IND.—H. E. Bucklen, of Chicago, who is building the electric road from Lagrange to South Bend through Elkhart, has announced his intention to issue $1,000,000 worth of ten and twenty-year bonds to cover the cost of the road, which is now nearly graded.

LEWISTOWN, MANITOBA—The preliminary survey is being made for an electric car line to run between Lewistown and Kendall. John L. Bright, of this city, is interested and says he is confident of the success of the plan. A company will be formed soon and work commenced.

SHARON, PA.—The building of the Sharon & Middlefield electric line is to be rushed. The line, forty-five miles long, will tap one of the richest farming districts in Ohio, and at Middlefield it will connect with the Cleveland & Eastern trolley line, giving a direct line from Sharon to Cleveland.

EAST ST. LOUIS, ILL.—Surveyors are at work in the vicinity of Madison and Granite City on the route of the new electric railway from East St. Louis, which is to connect with the Alton-Granite City Traction Company, thus forming a direct line from that city to East St. Louis.

EVERETT, WASH.—Both franchise and capital have been secured by E. G. Kruger, of Snohomish, to build an electric road from Index to Mineral City, to be used by the National Mining and Milling Company. A survey is now being made. Mr. Kruger says he has secured $50,000 from outside capitalists.

WINONA, MINN.—A trust deed given by the Winona Railway and Light Company to the Old Colony Trust Company has been placed on file with the register of deeds. This trust deed is to secure an issue of $400,000 first mortgage, five per cent, gold bonds, which are to run for a period of twenty years.

PINE CITY, WASH.—The commissioners of Spokane County have been petitioned for a franchise for an electric line from Spokane to the south line of the county. The proposed line will run from Spokane to Colfax through Pine City and Rosalia. The franchise for Whitman County has already been granted.

BALTIMORE, MD.—Work on the Northern Central Railway Company's enlarged electric power station at Mount Vernon yards is being rushed, and the plant will be ready for operation shortly. When completed it will furnish power for lighting purposes at Union and Calvert stations, and for lighting and power at the Mount Vernon shops.

MUNCIE, IND.—A movement has been started to construct a traction line from Dunkirk and Redkey to Eaton, where direct connection may be made for Muncie, Indianapolis and way stations. It is said that the Muncie, Hartford City & Fort Wayne Traction Company is behind the project. It would open a populous country to interurban patronage.

BELTON, TEX.—The grading on the Interurban electric car line has been completed up to the city limits and the poles have been set to within a short distance of the Leon river. The poles and ties have been distributed all along the streets to be traversed by the railway. The work is being pushed rapidly and the prospects are good for a completion of the road at a very early date.

ROCHESTER, N. Y.—The contract for constructing the road of the Rochester, Syracuse & Eastern Railway between Rochester and Newark has been let, and it is expected that work will be begun at once. There is a probability that the Rochester, Syracuse & Eastern may use the line of the Monroe County Electric Belt Line Company between Rochester and Fairport.

SALT LAKE CITY, UTAH—The Salt Lake & Mercur road has closed a contract to repurchase the Salt Lake & Utah Valley road. This line was formerly the West Side Rapid Transit. The line will be extended at once to Bingham cañon and an hourly electric service will be established. But fourteen miles remain to be built and this can be easily finished by the first of the year.

FORT COLLINS, COLO.—The city council has granted a franchise to the Northern Colorado Electrical Railway Company, which proposes to build an electric railway from Greeley to Denver via

Fort Collins, Longmont, Loveland and Boulder. The electric company proposes to haul both passengers and freight. A power plant will be located in this city, together with the general offices.

SYRACUSE, N. Y.—Clifford D. Beebe, president of the Auburn & Syracuse Electric road and the Auburn City Railway, announces that in all probability a line will be built soon from Auburn to Port Byran, a distance of eight miles. The road would connect at the latter point with the Rochester, Syracuse & Eastern. The company which will build the road will probably be capitalized at $250,000.

IRWIN, PA.—The council of Manor has granted the Pittsburg & Westmoreland Railway Company a franchise to build its line in the borough. This line will be part of the Irwin-McKeesport project. It will run from Irwin through Rillton, Madison and Edna No. 2 to Herminie. From here it will extend to Manor *via* Shafton and Westmoreland city. Nearly all the right of way has been secured.

MONTREAL, QUE.—The shareholders of the Suburban Tramways and Power Company have elected officers as follows: L. J. Forget, president; K. W. Blackwell, vice-president; Fred Henshaw, Sir Montagu Allan, Paul Gilbert, directors. W. G. Ross was named general manager and Patrick Dubee, secretary. This company was organized for the purpose of taking over the Longue Pointe and other projected lines.

DETROIT, MICH.—President E. M. Hopkins, of the Owosso & Pontiac Electric Railway, says that contracts have been let for the construction of sixty miles of road, and that work will be started at once. The company is capitalized at $1,800,000, and its officers are: president, E. M. Hopkins; vice-president, John T. Rich; treasurer, C. H. Pomeroy; secretary, Frank Westcott. Associated with them are J. L. Hudson, Governor A. T. Bliss and others.

GULFPORT, MISS.—The Coast Electric Railway chartered to run from Henderson Point to Point Cadet, a distance of thirty miles, is an assured fact, the right of way having been secured. Construction will cost about $350,000, and it is stated that this amount will be available within the next thirty days, when active work will begin at Gulfport and be carried on as rapidly as possible in both directions. The power-house will be located in this city.

PITTSBURG, PA.—Work on laying the track of a new street car line from Washington, Pa., to Duquesne will begin soon. This will be a direct line running between the towns in addition to running through thickly populated rural districts in Allegheny and Washington counties. The survey for the proposed line has been completed at Duquesne, where the line will connect with the Pittsburg, McKeesport and Connellsville tracks, which run through McKeesport.

MILWAUKEE, WIS.—An electric railway between Milwaukee and Beliot to connect with the Beloit-Janesville line is a possibility, and a movement is said to be under way to secure possession of the old Milwaukee-Beloit railway grade and right of way. This was secured in 1857 through efforts of Byron Kilbourn and others to construct a canal from Milwaukee to a Rock river point near Beloit. Milwaukee capital and electric railway promoters are supposed to be behind the present movement.

PASCAGOULA, FLA.—W. Denny & Company, of Moss Point, have been granted a franchise by the county board of supervisors to construct a tramroad across public roads and through school lands, known as sixteenth sections. This road will be of standard gauge to pass through the belt of heavily timbered land between Escatawpa river and Lucedale, a distance of about forty miles. The new road will connect with the Pascagoula Street Railway and Power Company's electric trolley line at Moss Point.

STROUDSBURG, PA.—A trolley line, running through the Pocono mountain region in Monroe, Pike and Wayne counties, seems to be assured. The following organization has been effected: John B. Williams, Stroudsburg, president; John D. Houck, La Anna, treasurer; George L. Waltz, Newfoundland, vice-president, and Arthur L. Simons, secretary. The new company will be known as the Pocono, La Anna & Newfoundland Railway Company. The East Branch Falls may be utilized for a power plant.

FOND DU LAC, WIS.—The Northeastern Electric Railway Company, which contemplates an interurban line between this city and Manitowoc, has elected new officers. They are Franklin Phillips, Brothertown, president; H. W. Wilson, Fond du Lac, vice-president; Otto B. Joerns, Sheboygan, secretary; Dr. G. P. McKenny, Stockbridge, treasurer. W. H. Phillips of this city was retired as president. No other business was transacted and no statement was given out of the present status of the company's plans.

EUGENE, ORE.—The Willamette Valley Electric Railway Company has been incorporated for $1,000,000 by J. F. Wilson, of Arizona, M. S. Taft, of Binghamton, N. Y., W. J. Wilsey, of Arizona, and others. Eugene will be the centre of operations. The county court is asked to give a franchise from Eugene to Blue River, Eugene to Florence, Eugene to Cottage Grove, Eugene to Junction, and on north to the county line. Benton County will be asked to give a franchise to Corvallis. The idea is to connect with the line from Salem to Portland. Plenty of capital is said to be behind the movement.

SPRINGFIELD, ILL.—The Edwardsville city council has granted a franchise to the St. Louis and Springfield electric line for use of certain streets on which to construct its tracks. By the terms of the contract work must be commenced in the city within one year and completed within two years, a $5,000 bond being required to protect the city from damages arising from the construction and operation of the road. The line is the one being constructed by the McKinley syndicate, between Decatur and Springfield and from the latter point to St. Louis *via* Carlinville and Edwardsville. The line is now completed between Springfield and Carlinville and will be in operation within a few days. The right of way is being secured for the St. Louis extension.

CONNELLSVILLE, PA.—The Meyersdale & Salisbury Street Railway connecting Garrett and Frostburg will be completed. Contracts for more than $500,000 worth of material, equipment and for the grading of the line have been let to Pittsburg firms. The line when completed will be nearly thirty miles in length and will connect all the important mining towns in the Georges Creek region, eventually connecting with Johnstown and Cumberland. The original charter was secured in Harrisburg in 1901 with a capital of $250,000. After securing rights of way the capital was increased to $1,500,000. Eight hundred thousand dollars will be spent before the road is put in operation. The president of the company is Orran W. Kennedy, of Uniontown; H. L. Borland is treasurer, and W. J. Ward, of Pittsburg, is secretary.

DANBURY, CT.—A mortgage under which the property of the Danbury & Harlem Traction Company is conditionally deeded to the Knickerbocker Trust Company, of New York, has been filed in the office of the local town clerk, and the old mortgage held by the Washington Trust Company, of New York, has been released. The new mortgage is for $500,000, while the amount secured by the former one was $200,000. The filing of the mortgage means that negotiations by which the Knickerbocker company will underwrite the bonds which the Danbury & Harlem company will issue have been completed. The directors have voted to put forth a bond issue of $500,000 in order to pay the company's outstanding obligations and to finish the interstate trolley line which the company is to operate between Danbury, Ct., and Golden's Bridge, N. Y.

CARLISLE, PA.—The purchasers of the railways, corporate property and franchises of the Cumberland Valley Electric Passenger Railway Company, the line of which runs from Mechanicsburg to Carlisle, have organized by the election of M. C. Kennedy, of Chambersburg, as president. The road lately became the property of the Valley Traction company which already operates lines from Harrisburg to New Cumberland, White Hill, Mechanicsburg, West Fairview and intermediate points and Carlisle. The officers of the new organization are those of the Valley Traction Company, and it will be known as the Carlisle & Mechanicsburg Street Railway Company. After Carlisle is reached the company may extend to Chambersburg, having acquired the right over the turnpike by purchase. The power-house at Bridgeport is undergoing extensive alterations and being very much enlarged for the purpose of not only supplying the company, but ior supplying Eiola yards, the towns all along the route and private individuals with light and heat.

NEW INCORPORATIONS.

RICHMOND, VA.—Damascus Telephone Company. $2,000.

CONCORD, N. H.—Henniker Telephone Company. $40,000.

MADISON, WIS.—Cambria Cooperative Telephone Company. $1,000.

MADISON, WIS.—Amberg Telephone and Telegraph Company. $3,000.

COLUMBUS, OHIO—Lewisburg Telephone Company. Increased to $20,000.

DOVER, ME.—The Sebec Power Company. Increased from $1,000 to $20,000.

POTTSVILLE, PA.—Buck Mountain Light, Heat and Power Company. $10,000.

AUSTIN, TEX.—The Electric Light and Ice Company. Increased to $20,000.

FRANKFORT, KY.—Oldham Telephone Company. Increased from $10,000 to $20,000.

ST. PAUL, MINN.—Hutchinson Telephone Company. Increased from $25,000 to $50,000.

LANSING, MICH.—The Palo Telephone Company. Increased from $6,000 to $10,000.

CLEVELAND, OHIO—The Adamsville Telephone Company. Increased from $10,000 to $30,000.

ALEXANDRIA, VA.—The Central Mutual Telephone Company. $5,000. William M. Wheeler, president.

CEDARVILLE, ILL.—Stephenson County Telephone Company. $7,000. Incorporators: S. W. Roberts and others.

ALBANY, N. Y.—The Burdett Home Telephone Company. $5,000. Incorporators: H. R. Martin, M. L. Martin and S. B. Allen.

AMITE CITY, LA.—The Amite Light and Power Company. $30,000. Incorporators: C. S. Stewart, D. H. Hull, F. E. Mayer.

MADISON, WIS.—Hudson Prairie Telephone Company. $3,000. Incorporators: George Turner, Arthur McDiamid and G. E. Holden.

GUTHRIE, OKLA.—LeClair Electric Company. $10,000. Incorporators: L. A. LeClair, B. F. Leggett and Charles E. Johnson.

SHELBYVILLE, ILL.—Windsor & Okaw Mutual Telephone Company. $900. Incorporators: J. W. Herron, J. F. Morse and J. H. Haste.

GARRETTSVILLE, OHIO—The Forde Lighting Company. $25,000. Incorporators: A. W. Greene, W. D. Martin, E. E. Martin and others.

ROCHESTER, N. Y.—Olmstead Electric Company. $30,000. Directors: M. J. Olmstead, J. O. Olmstead and Mary E. Olmstead, of Rochester.

SAYBROOK, ILL.—Saybrook Electric Light, Heat and Power Company. $10,000. Incorporators: E. E. Sayler, E. D. Sayler and B. J. Sayler.

MAJENICA, IND.—Majenica Telephone Company. $2,000. Incorporators: Sherman Sprowl, George W. Gill, J. F. Hoover, Daniel Shideler and C. W. Myer.

LANSING, N. Y.—Farm and Village Telephone Company. $20,000. Incorporators: R. Miller, Renselaer Miller, Lansing, N. Y.; Ivan Miller, Groton, N. Y.

EVANSVILLE, IND.—Cypress Telephone Company. $2,500. Directors: John F. Edward, John A. Neale, Edgar R. Levy, Louis B. Sirkle and Albert C. Kamp.

CINCINNATI, OHIO—The Youngstown Telephone Company; increased to $400,000. The Hillsboro Light and Fuel Company; increased from $40,000 to $52,000.

ALBANY, N. Y.—Knickerbocker Light and Heat Company, of New York. $550,000. Directors: F. P. Billmeyer, H. R. Brayton and H. S. Fairchild, of New York.

ST. PAUL, MINN.—Morton Rural Telephone Company. $25,000. Incorporators: F. W. Orth, F. W. Penhall, Fred Watschke, M. J. Egan, George Welch, R. B. Henton and Henry Beckman, all of Morton.

ATLANTA, GA.—White & Davis Telephone Company. To build lines in Shelby County. $10,000. Incorporators: J. R. White, W. I. Davis, W. P. White and N. Davis.

COLUMBUS, OHIO—The Dexter City Southwestern Telephone Company. $10,000. Incorporators: B. T. Worrell, Adam Shriver, G. W. Hutcheson and L. D. Headley.

PLATTSBURG, N. Y.—Lozier Light and Power Company. $100,000. Incorporators and directors for the first year: E. R. Lozier, H. A. Lozier, Jr., Samuel Regar, New York.

KANKAKEE, ILL.—Reddick Mutual Telephone Company. $5,000. Directors: H. G. Kluckholm, C. F. and Fred Prussner, Thomas Corcoran, James Reilly and Fred Husworth.

RALEIGH, N. C.—Raeford Power and Manufacturing Company. $200,000. Stockholders: J. W. McLaughlin, T. B. Upchurch and W. J. Upchurch, of Raeford, and John Blue, of Aberdeen.

ORRVILLE, OHIO—The Gemmill Telephone and Manufacturing Company. $60,000. Incorporators: James D. Gemmill, Thomas S. Dunlap, James Nicoll, Sr., L. R. Dunham and W. A. Tims.

SIDNEY, OHIO—The Sidney Light, Heat and Power Company. $150,000. Incorporators: H. T. Bailey, J. W. Brown, F. W. C. Bailey, Wilson Carothers, E. J. Griffis, Andrew Dobbie, George T. Spahr.

SAN FRANCISCO, CAL.—Webster Street and Park Railway. $150,000. Directors: Charles E. Wilson, T. A. Perkins, of San Francisco; J. H. Macdonald, Thomas Prather and John Charles Adams, of Oakland.

ST. JOSEPH, MO.—St. Joseph, Stanberry & Northern. $400,000. Officers: president and treasurer, George C. Sims, of Des Moines; vice-president, J. E. Patrick, of St. Joseph; secretary, S. F. Moore, of Terre Haute, Ind.; general manager, Mrs. Alice M. Butler, of St. Joseph.

DE KALB, ILL.—De Kalb & Southeastern Railroad Company. To build terminal railway connecting railways in De Kalb County. $10,000. Incorporators and first board of directors: R. F. Shellabarger, E. E. Watson, Judson Brenner and A. W. Fisk, of De Kalb, and R. C. Caples, of New York.

JERSEY CITY, N. J.—The Burke Electric Company; $30,000; incorporators, James Burke, F. E. Drake and Paul Wilcox. Conchas River Power Company; $125,000; incorporators, John F. Kelly, Bernard J. Mahoney and George E. Griswold.

ALBANY, N. Y.—The Russell Power and Manufacturing Company. To operate in Hamilton, Oneida, Herkimer, Otsego, Madison, Fulton, Montgomery and Schenectady Counties. $10,000. Directors: Charles R. Huntley, William R. Huntley and Daniel T. Nash, of Buffalo.

WASHINGTON, D. C.—Anderson Electric Company; $25,000; incorporators, D. M. Anderson, O. C. Salein, Jr., and W. A. Pate. The Nevada Electric Power and Transmission Company; $5,000,000; incorporators, Dr. Francis E. Williams, John Fletcher Purvis, Charles D. Williams, Harvey T. Winfield, Harry E. L. Barker, James W. Slye and Jesse H. Wilson.

COLUMBUS, OHIO—The Franklin County Telephone Company; to build a telephone line to Westerville, Gahanna, Worthington, Galloway, Groveport, New Albany, Dublin, Hilliards, Lockbourne, Harrisburg, Reynoldsburg, Flint, Alton, Amlin, Black Lick, Brice, Central College, Elmwood, Hayden, Pleasant Corners and Africa; $150,000; incorporators: Isaac B. Cameron, Seth L. McMillan, Ralph Reamer, Homer L. Rose. The Columbus Citizens' Telephone Company; increased from $750,000 to $1,250,000.

ENGINEERING SOCIETIES.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA—The May issue of the proceedings of the Engineers' Society of Western Pennsylvania contains the following papers: "The Effects of the Baltimore Fire," by W. N. Hazen; "Commercial Gas Analy-

sis in Stationary Hempel Apparatus," by H. C. Babbitt, and a topical discussion on forms and relative advantages of teeth in gears.

SOCIETE DES INGENIEURS CIVILS DE FRANCE—The bulletin of the Societe des Ingenieurs Civils de France, for June, 1904, contains a short article on pneumatic traction for mines in the United States, by M. A. de Gennes, and a long study of the steam turbine and its applications, by M. G. Hart. The latter paper gives descriptions of all types of turbine which have thus far been put forward.

THE ELECTRICAL ENGINEERING SOCIETY OF THE WORCESTER POLYTECHNIC INSTITUTE—The Electrical Engineering Society of the Worcester Polytechnic Institute, Worcester, Mass., has arranged the following local meetings: September 30, October 14, November 11, December 9, January 6, 1905; February 10, March 10, April 21 and May 12. Beginning with October 14, every other meeting will be devoted to discussions of the regular American Institute of Electrical Engineers' papers, while the alternate meetings will be addressed either by men from the Worcester Institute or outside speakers. At the last meeting of the society, the following officers were elected: president, Joseph A. Johnson, '05; vice-president, Willis L. Towne, '06; secretary and treasurer, Charles H. Gilbert, '05. The executive committee is composed of the above officers, together with Professor Harold B. Smith, Ernest C. Morse, '05 and A. T. Childs, '06.

EDUCATIONAL.

UNIVERSITY OF ILLINOIS—Edmund J. James, president of the Northwestern University, was elected president of the University of Illinois by the board of trustees last week. Since the resignation of Dr. A. S. Draper, President James has been the leading candidate for the position.

LELAND STANFORD JR. UNIVERSITY, Palo Alto, Cal., will offer in 1904-1905 for the first time laboratory courses in metallurgy. Desk accommodations provided for sixty-four students are very complete. The furnace room is equipped with gas and electric furnaces and electrical appliances for heat measuring. Special facilities are present for analyzing gases, oils and solid fuels, and there is also a small plant for cyanide working tests.

COLORADO COLLEGE—Professor Fred Crabtree has been selected to fill the chair of mining and metallurgy in the school of engineering at Colorado college. Professor Crabtree graduated from the Massachusetts Institute of Technology in 1889, since which time he has been engaged in practical work as an engineer, both in the East and West, gaining valuable experience. For nearly two years he was connected with the Minnequa steel works, at Pueblo, in the blast furnace department.

ROCHESTER MECHANICS INSTITUTE—A special pamphlet describing the mechanical arts courses at the Mechanics Institute, Rochester, N. Y., is now being distributed. The Institute offers mechanical, electrical and architectural courses, the work laid out in these being described in the pamphlet. These courses are intended to take students with a grammar school education or its equivalent, and in three years fit them for industrial pursuits. The general work covered comprises mathematics, physics, English history, drawing and shop practice. The special work in electricity includes the elementary theory and the study of electrical apparatus. This work is accompanied by a thorough laboratory course.

OBITUARY NOTICES.

MR. HARRY KEMP, superintendent of the Standard Electric Company, of Norfolk, Va., died of typhoid fever at Norfolk, on August 9, at the age of thirty-seven.

MR. JOHN ROSS, foreman on the city subway, in New York, aged fifty years, was accidentally drowned while bathing at Baltimore, on August 29. Mr. Ross leaves two children.

PROFESSOR CHARLES W. SHIELDS, prominent in the scientific departments of Princeton University, died at Newport, on August 26, from heart failure, at the age of seventy-six.

MR. C. A. SCHENK, a civil engineer, died at Berkeley, Cal., at the age of sixty-eight. Mr. Schenk was a native of Germany, and a graduate of the Freiburg University, Saxony, and at one time professor of mineralogy at the Imperial College of Japan.

MR. WILLIAM G. JONES, a well-known telegrapher, was drowned in Jamaica bay, L. I., on September 1. Mr. Jones was fifty-three years of age, a native of Pennsylvania, and for a number of years was manager of the Western Union Telegraph Company in Philadelphia. When the United Press was organized he entered its service, and became the day manager of its head office in New York city. He was with the Associated Press in New York from 1897 to 1903.

MR. JOSEPH DAVID EVERETT, whose death in England was announced recently, was closely identified with electrical science. He entered the University of Glasgow in 1854, and studied under Lord Kelvin, graduating with honors. He was made professor of mathematics at King's College, Nova Scotia, which post he resigned in 1864. He was appointed to the chair of natural philosophy at Queen's College, Belfast, Ireland, in 1867. He made many valuable studies in thermodynamic measurements, and as secretary to the committee appointed by the British Association in 1871 for the selection and nomenclature of dynamic and electrical units, he suggested the names "dyne," "erg" and "C. G. S.," and drafted the report issued in 1873. He published, in 1900, a version of Deschanel's "Traité de Physique," the third section of which consisted almost entirely of new work. This dealt with the fundamental principles of modern electrical theory, as reported by Maxwell and Heaviside. In 1879, he was elected a fellow of the Royal Society. Professor Everett was a hard thinker and a great worker, and it may truly be said that he devoted his life to the advance of the science.

MR. RICHARD S. WARING died on Tuesday afternoon, August 23, at Elmira, N. Y. Mr. Waring was formerly one of the most prominent citizens of Pittsburg, Pa., and a pioneer in the distinctive business of underground cable manufacture in the United States. For several years past he has resided at Elmira. He was born in Saratoga County, N. Y., in 1833, and went to Pittsburg, where he began his business career in 1856 or 1857. After a short term in the service of the Citizens' National Bank, of Pittsburg, he entered the employ of R. E. Sellers & Company, manufacturers and wholesale druggists. When this company built its first oil refinery on the Alleghany river, near Sharpsburg, Mr. Waring was made manager, and from this time on engaged in the oil business, which, at the time of his entering into it, was a comparatively new industry. Mr. Waring's energy and enterprise soon gave him a leading position in the oil business, and he was at one time one of the most prominent oil refiners of Pittsburg, and a noted competitor of the Standard Oil Company. His firm operated the Vesta Oil Works and the Cosmos Oil Works directly, and financed a number of other refineries, operating them under lease or controlling their entire output. One of the largest and most enduring achievements of Mr. Waring was the founding of the Standard Underground Cable Company. This company has become one of the most prosperous manufacturing corporations of Pittsburg, and one of the most successful of its character in the country. Mr. Waring's knowledge of the oil business was extremely valuable to him in perfecting his cable system, for it suggested to him and enabled him to produce a most valuable insulating compound from petroleum products. Upon this insulating compound and other features of cable manufacture he secured letters patent both in the United States and in all important foreign countries. He was a member of the American Institute of Electrical Engineers. He is survived by his wife; his son, Tracy D. Waring, assistant superintendent of Perth Amboy works of the Standard Underground Cable Company, and a daughter, Mrs. James Robinson.

MR. RICHARD S. WARING.

TELEPHONE AND TELEGRAPH.

BROOKLYN, PA.—A telephone line is being put in from this place to Alford.

TOPEKA, KAN.—The Herington Telephone Exchange has been sold to A. B. Clark, of Oskaloosa.

ALTON, ILL.—The Kinloch Telephone Company has commenced work in its toll line to Springfield.

ONEONTA, N. Y.—It is stated that a new local telephone line is to be built from Milford to Oneonta.

DULUTH, MINN.—The Tri-State Telephone Company has extended its line from Winona to La Crosse.

SOUTH McALLISTER, I. T.—A franchise has been granted to the Independent Bell Telephone Company.

JOHNSTOWN, PA.—The Bell Telephone Company is erecting poles and wires within the limits of Meyersdale.

LINCOLN, NEB.—The Automatic Telephone Company has erected a new line to Yankee Hill and Burnham.

HUTCHISON, KAN.—The Missouri & Kansas Telephone Company will practically rebuild its system in this city.

ALTON, ILL.—The Kinloch Telephone Company is purchasing the right of way for a new toll line from Alton to Jacksonville

SAN DIEGO, CAL.—The Sunset Telephone and Telegraph Company has decided upon the reconstruction of its San Diego plant.

WILLIAMSPORT, PA.—The Sullivan & Wyoming and Sullivan County lines have agreed to establish a union exchange at Dushore.

UTICA, N. Y.—The trustees of the village of Canastota have voted to grant a franchise to the Canastota Telephone Company.

NEW HAVEN, CT.—The American De Forest Wireless Telegraph Company has secured land in this city for the erection of a wireless station.

TRENTON, N. J.—A telephone line is being strung along the Trenton, Lawrenceville & Princeton Railroad from this city to Princeton.

ITALY, TEX.—R. B. Lockhart, of Pittsburg, has sold his telephone exchange at this place to C. M. Mitchell, the consideration being $5,500.

CEDAR FALLS, IOWA—The Iowa Telephone Company will completely remodel its system in this city, and also rebuild its line to Waterloo.

SCRANTON, PA.—Improvements costing more than $250,000 are now being made in the system of the Pennsylvania Telephone Company, in this city.

GOSHEN, N. Y.—The Monticello Telephone Company has elected G. L. McLaughlin, president; G. L. Hatch, secretary, and H. F. Holmes, treasurer.

CONNELLSVILLE, PA.—The Tri-State Telephone Company began the construction of a line two and one-half miles long, from Dawson to Flatwoods.

SEDALIA, MO.—It is announced that the American De Forest Wireless Telegraph Company will install a station in this city within the next few weeks.

WINONA, MINN.—The long-distance connection between the Winona Telephone Company and the line of the Tri-State Telephone Company has been completed.

CARRABELLE, FLA.—W. C. Lewes has been granted a franchise to install a telephone system giving Carrabelle connection with Thomasville, Ga., and Tallahassee.

ABERDEEN, MISS.—At an adjourned meeting the city council granted a franchise to the Cumberland Telephone Company to open a local and long-distance exchange here.

PORTLAND, ORE.—The Pacific States Telephone Company is making arrangements to extend its lines from Whitney to the new town of Tipton, a distance of eight miles.

HAMILTON, OHIO—The Hamilton Home Telephone Company announces that it will entirely rebuild its Scipio line, recently purchased from the Scipio Telephone Company.

EAST LONGMEADOW, MASS.—The selectmen have granted a franchise to the New England Telephone Company to erect poles as a preparation for putting in about forty new telephones.

STARKVILLE, MISS.—The town council has granted to the Cumberland Telephone Company a franchise for the establishment and operation of a telephone system within the city limits.

STERLING, ILL.—The Lee County Telephone Company will rebuild its system of telephones in Dixon and throughout the country district. An underground system will be installed, the work to cost $75,000.

CHATTANOOGA, TENN.—The Citizens' Telephone Company has let the contract for the building of a new line from Columbia to Losea, Tenn., and to points beyond. Several other extensions are also contemplated.

INDEPENDENCE, ORE.—The city council has granted a franchise to an independent company, which will give connection with Dallas, Falls City, McMinnville, Amity, McCoy, Corvallis, Newberg and Independence.

BOWLING GREEN, KY.—The Home Telephone Company has nearly completed its new line from this city to Scottville. The connections have already been made at Greenwood, Alvaton, Allen Springs and Halfway.

HARTFORD, CT.—The American Telephone and Telegraph Company is building a new line through the state from the West Hartford testing station through to Waterbury, and the line may extend through to Poughkeepsie.

LAKE PRESTON, S. D.—A new rural telephone line is in course of construction from this place to the territory north and west of the town, and it is said that another line will shortly be built to the farming community west and south.

BAINBRIDGE, GA.—The Bainbridge telephone exchange, belonging to W. W. Collier, has been sold to a party of local capitalists, who will at once incorporate, improve and extend the system. The consideration is supposed to be about $15,000.

SCHENECTADY, N. Y.—By about the middle of September it is expected that Schenectady and Ballston will be connected by a new telephone line, the system to be the property of the Schenectady Railway Company. The line will run along its Ballston division.

WINDSOR, MICH.—The incorporators of the Independent Telephone Company, which is applying for franchises in Windsor, Walkerville and Sandwich, are: C. W. Taylor, R. Brooks, J. A. McRae, P. T. Chesty and A. D. Prosser, all of Detroit. The capital is $100,000.

FLORENCE, COL.—The Colorado Telephone Company intends to extend its line from Portland to the farm houses and ranches along Beaver creek. This section of the Arkansas valley is densely populated and it will give the people direct connection with the markets of the county and state.

STOCKTON, KAN.—The Woodston Mutual Telephone Company has been formed for the purpose of building two lines into Stockton. One is a commercial and the other a party line. Arrangements are being made to cooperate with the Stockton and Webster exchanges and rural lines.

WILLIAMSPORT, PA.—The Huntington & Clearfield Telephone Company has extended its line from Peale to Snow Shoe. At the latter place the company connects with the United Telephone Company's line, giving service to Bellefonte, Lock Haven, Williamsport, Tyrone, Altoona and intermediate points.

MORRISTOWN, TENN.—On September 12 will occur the sale of the property and franchises of the Citizens' Telephone Company, of Morristown. The sale is to be under a deed of trust to secure to J. W. Fisher a note of $7,000. The property consists of the local exchanges here and at White Pine, ten miles distant.

HOUSTON, TEX.—The Southwestern Telegraph and Telephone Company is making some extensive improvements in its exchanges in this city and at Fort Worth. The present switchboard in the Houston office accommodates 4,400 telephones, but will be increased in size until it will meet all requirements for several years to come.

SEATTLE, WASH.—Direct telephone communication between Vancouver, B. C., and the various cities along the Pacific coast is stated to be a certainty. Arrangements are practically completed for the installation, by the New Westminster & Burrard Inlet Telephone

Company, of Canada, and the International Telephone Company, of Bellingham, of a telephone cable line to connect, on a direct wire, Bellingham and Vancouver. From Bellingham an exchange will connect, by means of the Pacific States Telephone Company, all the Coast points.

READING, PA.—The Conestoga Telephone and Telegraph Company has completed its line to Birdsboro. It touches Morgantown, White Bear, Churchtown, Geigertown, Joanna and Elverson. It is said to be the purpose of the Consolidated Telephone Company to connect with this company. A line will probably be built from Reading *via* Millmont.

MILL CREEK, I. T.—Work has been commenced on the feeder line from the Missouri Telephone Company's line, now building, through the Chickasaw nation from Oklahoma city to Denison. With this line completed Mill Creek will have long-distance connections as far north as Kansas City and St. Louis, and to all important Texas points.

WILLIAMSON, N. Y.—At a meeting of the stockholders of the Wayne-Monroe Telephone Company held in this village it was decided to increase the capital stock from $30,000 to $100,000. The company was formed last year by Rochester, Lyons, Walworth. Ontario and Williamson men to build a line in the western part of the county.

ST. JOHN, NEW BRUNSWICK—The New Brunswick Telephone Company has constructed a line from Woodstock to Canterbury and Benton, and it is now giving service. A line is being constructed from Grand Falls to Edmundston, and a new wire is being laid from St. John to Fredericton. The company is also erecting buildings of its own in St. Stephen and Moncton.

JACKSON, MICH.—Throughout the summer the Citizens' Telephone Company, of this city, has been doing a large amount of construction work. In the county alone 500 new poles have been erected and 125 miles of new wire stretched. An exchange has also been erected in the village of Napoleon, and this exchange is already connected with 120 subscribers. This fall 35,000 feet of cable is to be laid in Jackson.

CLARKSVILLE, TENN.—The Cumberland Telephone and Telegraph Company is having a through line built from Clarksville to Dickson, Tenn. A force of workmen is now at work and it will be completed in a short time. This will give Clarksville direct communication with parties in that section. At present parties desiring to talk to Dickson must call through Nashville. The following towns will be on the line: Louise, Slayden, Woods Valley and Cumberland Furnace.

CARLYLE, ILL.—The telephone lines of Clinton County have been consolidated and are now operated under one management. George Johnspeter, who owned the line from Posey, Hoffman and Keysport to Carlyle, has purchased the interests of the Southern Union Telephone Company, in this county, which includes the exchanges at Carlyle, Breese, Trenton and Germantown. The consideration was $5,000. The lines will be extended to all towns, villages and points in the county.

OXFORD, N. Y.—Work will be commenced on the line of the Oxford Valley Telephone Company. The line will connect at the Halfway House with an independent line from Norwich, which will be extended from Norwich to that point. At Brisben the new line will connect with an independent line that runs to Binghamton. It is expected that this line will give night and day service. The officers of the new company are George B. Fletcher, president; F. E. Beadle, vice-president; M. T. Whitney, secretary and treasurer.

INDIANA, PA.—At a meeting of the executive committee of the Farmers' Telephone Company it was decided to string a through wire from Indiana to Punxsutawney by way of Plumville. The company has recently acquired the lines between Penn Run and Indiana, Uniontown and Cookport, Cool Spring and Knoxdale, and Cookport and Douglass. The company's system is growing rapidly, and it now controls about 800 miles of lines in Indiana, Jefferson and Armstrong counties. Several new lines are in course of construction.

TORONTO, ONT.—Detroit citizens have organized a telephone company with an authorized capital of $100,000 and have obtained a charter to do business in Ontario. They are empowered to carry on the general business of a telephone company, with various restrictions as to the erection of poles and wires, which guard the rights of private and municipal property. The incorporators are the following: C. W. Taylor, R. Brooks, J. A. McRae, P. T. Chesley, A. D. Prosser. The company proposes to begin its Ontario operations in the county of Essex.

MILWAUKEE, WIS.—A new line to Madison, costing $30,000, is being planned by the Postal Telegraph-Cable Company. At present the business between the twin cities is carried on by way of Chicago, there being no direct connection. The company hopes to have the line in operation next winter. In the near future the Postal company expects to reach out in portions of the state now unoccupied by it, the lines radiating from Madison and Milwaukee as centres. By next year it is planned to have a line to Eau Claire.

ST. JOSEPH, MO.—Contracts for two new central energy switchboards for the Missouri & Kansas Telephone Company's exchange have been let, and the boards will be delivered January 1. The new switchboard for the main exchange will accommodate 3,000 telephones, while a board to accommodate 1,200 telephones will be installed at the same time in the South St. Joseph exchange. In addition to the new switchboards, twenty-four new cable extensions will be made. Cables will be extended to parts of the city that have been without telephone service and lines will be strung to the most remote sections. The new cables are expected not later than September 15. The work is to cost $150,000.

ST. JOSEPH, MO.—The Funston Long-Distance Telephone Company has established a new long-distance system which is operated in connection with the Citizens' Telephone Company. This gives St. Joseph connection over the independent lines with St. Louis, Kansas City, Jefferson City, Joplin, Sedalia, Topeka and Pittsburg, Kan., and hundreds of other points in Missouri, Kansas, Nebraska, Iowa, Indiana, Ohio, Illinois, Michigan and Kentucky. The Funston company will construct a line from St. Joseph to Cambridge, thence to Chillicothe, tapping the independent line at Hamilton, thence north through Gallatin into Iowa. Fifty thousand dollars will be expended on this system.

YANKTON, S. D.—It is reported that a combination has been formed between the new Yankton telephone exchange, the Bruce lines, the Citizens' exchange, of Sioux Falls, and the exchange now being built by the business men of Sioux Falls, together with the Ward lines and the several smaller companies in the small towns between the three cities. Lines will be built by the new company to Mitchell, Aberdeen, Watertown, Brookings and all the principal towns east of the Missouri river and in western Iowa. The Sioux City exchange will cost $350,000, and is backed by the business men and bankers of the city. The Yankton exchange is owned by the business men of the city and is doing the larger part of the local business. The Ward lines cover five counties east of the Missouri river, with exchanges in all towns. The Bruce lines cover Yankton county completely and branch out into all adjoining counties. The aggregate capital of the new company will be about $1,000,000. The headquarters will be either in Sioux City, Sioux Falls or Yankton.

BURLINGTON, VT.—The local division of the New England Telephone and Telegraph Company has made a number of extensions to the system within the past few months. Two circuits have been put in between White River Junction and Bellows Falls, a distance of forty miles; one circuit between White River Junction and Littleton, N. H., a distance of sixty-three miles; between White River Junction and Bradford, a distance of twenty-nine miles; one circuit between Claremont and Newport, N. H., a distance of eleven miles; one circuit between Claremont, N. H., and Windsor, a distance of fourteen miles; one circuit between Lancaster and Berlin, N. H., a distance of thirty-one miles, and one circuit between St. Johnsbury and Littleton, N. H., a distance of eighteen miles. Besides these, the company has authority to place a circuit between this city and Rutland, a distance of sixty-seven miles. Before placing this circuit, the line must be rebuilt, and this work has already been commenced. In all, the division has obtained authority to place 705 miles of copper wire; 265 miles of iron wire, 8,353 crossarms and 5,096 poles. In addition to the foregoing, the company will use in the neighborhood of 1,000 poles in the construction of farmers' lines before the season closes.

INDUSTRIAL ITEMS.

THE DODGE MANUFACTURING COMPANY, Mishawaka, Ind., has issued a condensed price list of its power transmission goods.

THE NERNST LAMP COMPANY, Pittsburg, Pa., has issued a pamphlet devoted to store lighting, for which the Nernst lamp seems well fitted.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY'S calendar for September contains a picture and short biography of Frank J. Sprague.

THE FOUR-TRACK NEWS, published by Mr. George H. Daniels, for September, is an usually good number. The leading article, with appropriate illustrations, on Venice, is interesting and well written.

THE FAHNESTOCK TRANSMITTER COMPANY, Brooklyn, N. Y., is manufacturing a spring binding post. The spring requires no screws for the fastening of the wire. These attachments are easily made and good contacts insured.

THE PEERLESS ELECTRIC COMPANY, successor to the Warren Electric and Specialty Company, Warren, Ohio, has published a catalogue describing the Peerless transformers. These transformers are mounted in moistureproof iron cases and may be operated either dry or with oil.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., has removed its offices from the factory, Thirty-first and Ludlow streets, to Thirty-second and Arch streets. The constantly increasing demand for "P. K." specialties rendered this move necessary in order to provide additional factory space.

THE EDISON LIGHT, for September, published by the Edison Electric Illuminating Company, Boston, Mass., contains a number of interesting articles, supplemented by high-class half-tone engravings. The new advertising sign on the Edison company's chimney, at the Head place station, is shown in half-tone.

THE FRANKLIN ELECTRIC MANUFACTURING COMPANY, Hartford, Ct., has published a booklet devoted to the advantages of the "Femco" lamps. These lamps are the product of a modern factory and the result of long experience and experiment. The Sachs Electric Company, St. Louis, is the southwestern representative.

THE FIDELITY ELECTRIC COMPANY, Lancaster, Pa., has arranged for Machado & Roller, 203 Broadway, New York city, to be its selling agents for New York and the surrounding territory. Machado & Roller will handle the Fidelity Electric Company's line of power motors and generators, and will carry a complete line in stock for immediate delivery.

THE H. W. JOHNS-MANVILLE COMPANY, New York, N. Y., has issued a temporary price list, No. 101, for use until the large catalogue is ready for distribution. To the "Noark" line a number of fuses have been added with capacities up to 600 amperes in both 220 and 500 volts, also fuse and service boxes for 220-volt two and three-wire systems for the reception of the standard type "C" fuses up to 600 amperes.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, in bulletin 231 describes direct-connected generators of the marine type. These machines are destined to combine compactness of form with efficiency and durability. They are particularly adapted to marine work or very limited floor space. The generators are arranged for direct-connection to any standard make of engine, either vertical or horizontal.

MACHADO & ROLLER, 203 Broadway, New York city, have taken the eastern sales agency for the dynamos and motors manufactured by the Fidelity Electric Company, Lancaster, Pa. The Fidelity company makes a specialty of small apparatus and of special motors; such as, polishers and buffers, elevator motors, vertical-type motors, small rotary converters for transforming direct into alternating current for therapeutic work.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., has just installed through its Cincinnati office the first consignment of motors in the factories of the Columbus Buggy Company. This equipment consists of twenty-six motors, aggregating nearly 300 horse-power. The power will be supplied by the Columbus Citizens' Light and Power Company. The Cincinnati office has also closed a contract with the Kentucky Wagon Manufacturing Company for a 400-kilowatt engine type generator.

THE MILNE BOILER COMPANY, New York, has issued a catalogue descriptive of its high-pressure boiler and superheater and of the Milne steam superheater. The former is of simple construction, having only four members. The boiler is built in accord with the best standard practice, wrought steel being used throughout. The construction combines a boiler and economizer. In the steam superheater there are only three members, but every element necessary for the efficient production of superheated steam is present.

THE CUTTER COMPANY, Philadelphia, Pa., has produced a striking advertisement adopting an old saw to modern advertising methods. This advertisement represents a block of wood, upon which are pasted a number of postage stamps of various denominations. Cut into the wood is the sage advice of Josh Billings to his son, concerning the ability of a postage stamp to stick to one thing until it gets there. The Cutter Company announces that it has stuck to "I-T-E" circuit-breakers, and advises its friends to do likewise.

THE ELECTRO-DYNAMIC COMPANY has removed its headquarters from Philadelphia, Pa., to a new factory at Bayonne, N. J. This step has been made necessary by the constantly increasing demand for the company's specialties. The new works will be modern in every respect, and will provide for largely increased facilities. A power system for industrial plants requiring variable-speed motors will be one of the company's leading lines. The motors for this system will be specially designed for the work, and will be capable of successfully handling the machines they are installed to drive.

THE INTERNATIONAL ACHESON GRAPHITE COMPANY, Niagara Falls, N. Y., is issuing a cordial invitation to engineers to visit its exhibit space at the head of aisle S, section 1, in the Palace of Electricity. Attention is called to the Acheson graphite compound for the protection from corrosion of structural iron and steel. The exhibit includes not only many interesting specimens of Acheson graphite, but there are also shown four miniature electric furnaces illustrating its method of manufacture. The exhibit will show, in addition to the above, some styles of Acheson graphite electrodes as actually employed in electrolytic and electrometallurgical work.

THE AMERICAN ELECTRIC AND CONTROLLER COMPANY, 12 Dey street, New York city, is exhibiting a new type of controller for electric motors. This method of control is original, and, the company claims, will warrant the close investigation of engineers. A great variation of speed is secured, at a high economy in current consumption. The controller can be applied to any standard shunt or compound-wound motor, and operates on the ordinary two-wire system. No starting box is required, and graduated speed is secured, eliminating steps. The controller is not only adapted for machine tool work, but can be used wherever variable speed is required. It is shown in practical operation at the above address. The company will be pleased to mail further information upon request.

THE COOPER HEWITT ELECTRIC COMPANY, 220 West Twenty-ninth street, New York city, in bulletin No. 5 describes the Cooper Hewitt mercury vapor electric lamp for general illumination and photographic uses. This bulletin shows a number of instances of the adaptation of the Cooper Hewitt lamp for various forms of lighting. The company is also distributing a leaflet describing the moving pictures shown in the Westinghouse auditorium, Machinery Hall, Louisiana Purchase Exposition, St. Louis, Mo. These pictures were made with the aid of Cooper Hewitt lamp. The company was favored with a visit by the members of the Associazione Elettrotecnica Italiana on August 31. Each of the guests was handed a cleverly prepared photographic souvenir purported to be a translation of a page from a note book of one of the visitors.